923 899

IRD Mechanalysis

OPERATION AND MAINTENANCE INSTRUCTIONS FOR MODEL 350 VIBRATION ANALYZER/ DYNAMIC BALANCER

PN# 9767

INDEX TO CONTENTS

Title	Page
INTRODUCTION	1
DESCRIPTION	2
Front Panel	2
Side Panels	5
Instrument Case and Accessories	7
SPECIFICATIONS	10
Model 350 Vibration Analyzer/Dynamic Balancer	10
Model 544 Vibration Pickup	13
PREPARATION PROCEDURE	15
Power Line Operation	15
Battery Operation	16
Analyzer Case Purging	16
OPERATION	17
Vibration Measurement	17
Vibration Analysis	17
Balancing	19
Obtaining Machinery Vibration Signatures	29
X-Y Recorder Setup Procedures	31
MAINTENANCE	34
Recharging Batteries	34
Battery Replacement	34
Strob Lamp Replacement	38
Operating Voltage Changeover	39
CALIBRATION PROCEDURES	41
Meter Zero Adjustment	41
Gain Adjustment	41
Filter Calibration	42
Frequency Meter Calibration	45
Filter Dial Adjustment	46
Power Supply Voltage Adjustment	47
SPECIFICATIONS FOR MODEL 1080 X-Y RECORDER	48
AUTHORIZED SERVICE DEPOTS	49
Ordering Replacement Parts	49
Obtaining Service	50

INDEX TO ILLUSTRATIONS

Figure	Description	Page
1	The Model 350 Vibration Analyzer/Dynamic Balancer	1
2	Model 350 Front Panel	2
3A	Left Side Panel	5
3B	Right Side Panel	5
4	Model 350 Case	7
5	Accessory Storage	7
6	Model 350 Standard Accessories	8
7	Vibration History Form	20
8A	Vibration Severity Chart in Mils	21
8B	Vibration Severity Chart in Microns	22
9	Vibration Identification Chart	23
10	Original Unbalance Readings	24
11	Reading With Trial Weight (O+T)	24
12	Fundamental Rules of Balancing	27
13	Simplified Vector Diagram	28
14A	X-Y Recorder, Model 1080 Illustration	29
14B	X-Y Recorder, Bottom View Showing Cables and Inputs	30
14C	Typical Vibration Signature	33
15	350 Case	35
16	350 Interior	35
17	350 Interior	35
18	350 Top Interior	35
19	350 Top Interior	36
20	Instrument Batteries	37
21	Main Terminal Board	38
22	Calibration Setup	42
23	Adjustment Potentiometer Locations	43
24	Filter Dial Details	47

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09545

Introduction

Conditions in a machine that eventually result in breakdown and extensive repairs can be detected by the vibration they cause. An increase in the severity of such mechanical troubles is revealed by increased vibration. These vibrations are often complex and require a capability to separate one from the others if the trouble is to be found. The Mechanalysis Model 350 Vibration Analyzer/Dynamic Balancer not only has this capability, but is equally suited for in–place dynamic balancing.

This manual is written to provide you with an understanding of how the instrument is operated. For details on its application, IRD MECHANALYSIS, INC. has available a comprehensive training program which covers vibration measurement, analysis, identification and dynamic balancing. Using the latest techniques, the Mechanalysis Audio–Visual Training Program is conducted in principal cities throughout the U. S. A., Canada, Western Europe, United Kingdom and South Africa at no charge to you. For details contact your nearest IRD MECHANALYSIS, INC. office.

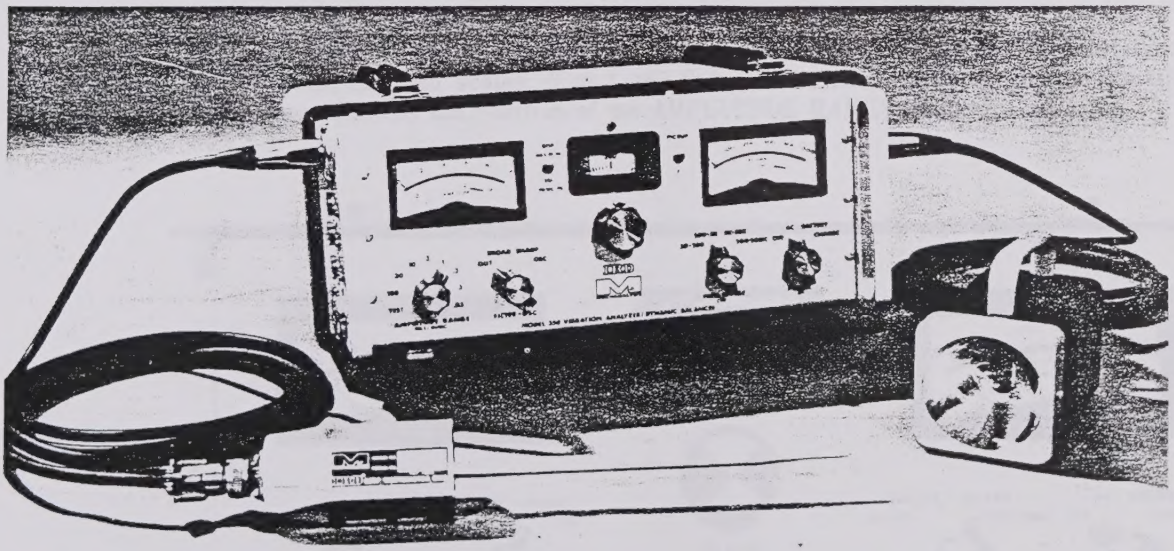


Figure 1. The Model 350 Vibration Analyzer/Dynamic Balancer

Description

The Mechanalysis Model 350 Vibration Analyzer/Dynamic Balancer uses the latest solid–state integrated circuitry to provide a complete instrument for accurate vibration measurement and analysis and in–place dynamic balancing in a light–weight, rugged, compact unit. Battery operation is provided to allow maximum flexibility and utility.

An additional outstanding feature of Model 350 is that it provides DC voltage outputs of amplitude and filter frequency to permit direct plotting of machinery vibration "signatures" when used with optional XY Recorder, Model 1080. See Machinery Vibration "Signatures".

FRONT PANEL

The 350 front panel (see figure 2) is arranged according to functions for convenience of operation. The left side of the panel contains the AMPLITUDE METER, AMPLITUDE RANGE SELECTOR, DISPLACEMENT–VELOCITY SELECTOR and FILTER–OSCILLATOR SELECTOR.

The right side of the panel contains the FREQUENCY METER, POWER SELECTOR, FREQUENCY RANGE SELECTOR and PICKUP SELECTOR. The middle of the panel contains the FILTER TUNING DIAL, the FILTER TUNING CONTROL and the POWER INDICATOR LAMP.

AMPLITUDE METER (Figure 2)

The AMPLITUDE meter indicates the peak–to–peak displacement or peak velocity of vibration. The meter has two scales, 0 to 1 and 0 to 3. The scale used to read the vibration amplitude is determined by the position of the AMPLITUDE RANGE selector.

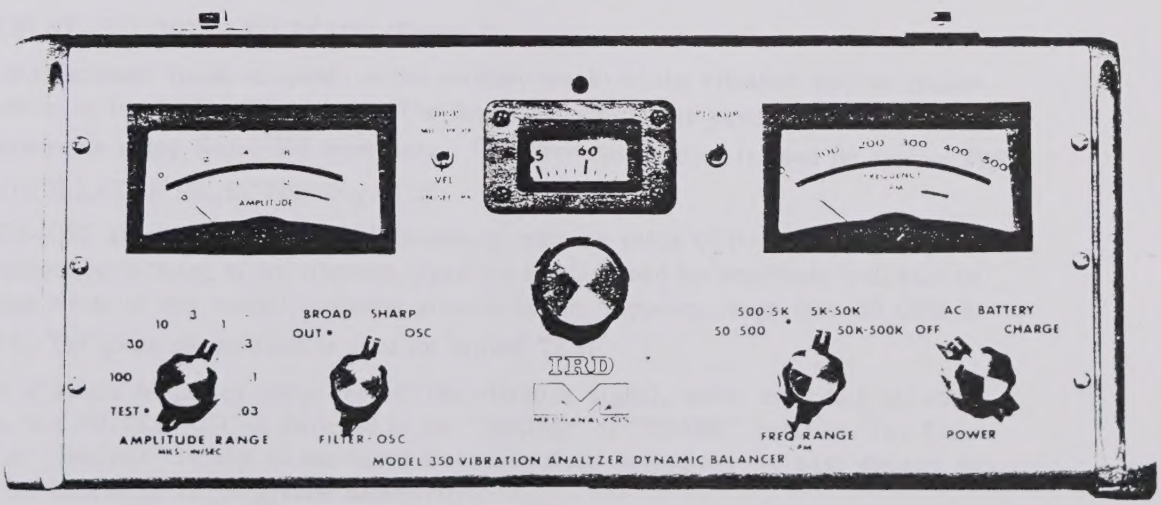


Figure 2. Model 350 Front Panel

The green "TEST" area of the AMPLITUDE meter is used in conjunction with the TEST position of the AMPLITUDE RANGE selector to check the instrument for proper operation. The dB scale permits sound analysis, using the Mechanalysis Model 308 Vibration/Sound Level Meter as a signal source. (Instructions are given in the Model 308 manual).

AMPLITUDE RANGE SELECTOR (Figure 2)

The AMPLITUDE RANGE selector determines the full–scale meter range of the AMPLITUDE meter. For instruments measuring vibration amplitude in English units, peak–to–peak displacement is indicated in mils (1 mil = .001 inch). Velocity is indicated in inches per second peak. Full–scale amplitude from .03 to 100 mils or inches per second are covered in eight ranges: 0 to .03, 0 to .1, 0 to .3, 0 to 1.0, 0 to 3.0, 0 to 10.0, 0 to 30.0 and 0 to 100.0. Positions marked 100, 10, 1 and .1 are used with the top meter scale (0 to 1). Positions marked 30, 3, .3 and .03 are used with the bottom meter scale (0 to 3). Each position indicates the full scale range of the AMPLITUDE meter for that setting.

For instruments measuring vibration amplitude in Metric units, peak–to–peak displacement is indicated in microns. Velocity is indicated in millimeters per second. Full–scale amplitudes from 1 to 3000 (microns or millimeters per second) are covered in eight ranges: 0 to 1.0, 0 to 3.0, 0 to 10.0, 0 to 30.0, 0 to 100.0, 0 to 300.0, 0 to 1000.0, and 0 to 3000.0. Positions marked 1000, 100, 10 and 1 are used with the top meter scale (0 to 1). Positions marked 3000, 300, 30 and 3 are used with the bottom meter scale (0 to 3). Each position indicates the full scale range of the AMPLITUDE meter for that setting.

The TEST and green dot position on the AMPLITUDE RANGE selector is used in conjunction with the green "TEST" area of the AMPLITUDE and FREQUENCY meter to check the instrument for proper operation. See "Circuit Operation Check" in the section PREPARATION PROCEDURE.

The Sound dB position is used for sound pressure level measurements using Model 308 accessory.

DISPLACEMENT–VELOCITY SELECTOR (Figure 2)

Either the displacement (peak–to–peak) or the velocity (peak) of the vibration may be chosen for measurement by the DISP-VEL switch. The Sound dB position is used for sound pressure level measurements using Model 308 accessory. The green dot position is used for system TEST.

FILTER –OSCILLATOR SELECTOR (Figure 2)

The FILTER–OSC selector determines the frequency response range of the instrument. In the "OUT" position, no filtering of the vibration signal takes place and the amplitude indicated on the amplitude meter is the overall vibration present in the frequency range from 50 CPM to 500,000 CPM. The green dot position is used for system TEST.

To observe a single frequency component of the vibration signal, while excluding all other frequencies, the FILTER–OSC is switched to the "BROAD" or "SHARP" position. The filter bandwidth in "BROAD" is 10% of the tuned frequency (less selectivity for easy tuning); in "SHARP" the bandwidth is 5% (greater selectivity).

To use the Model 350 as a strob–tachometer, the FILTER–OSC selector is switched to "OSC". This energizes an internal oscillator which will flash the stroboscopic light at a rate corresponding to the frequency set by the FREQ RANGE selector and the filter tuning dial.

FREQUENCY METER (Figure 2)

The FREQUENCY meter indicates frequency of vibration in cycles per minute (CPM) from 60 to 500,000 CPM in four ranges as selected by the FREQ-RANGE selector. In "Filter Out" the meter reads the predominant vibration frequency or a multiple of this frequency. In "Filter In" the meter reads the filtered frequency, and in "Osc" it indicates the internal oscillator frequency.

The green "TEST" area of the FREQUENCY meter is used in conjunction with the "TEST" position of the AMPLITUDE RANGE selector to check the instrument for proper operation. See "Circuit Operation Check" in the section PREPARATION PROCEDURE.

FREQUENCY RANGE SELECTOR (Figure 2)

The filter or oscillator frequency range in cycles per minute (CPM) is determined by the FREQ RANGE selector setting. There are four ranges: 50 CPM to 500 CPM; 500 CPM to 5000 CPM; 5000 CPM to 50,000 CPM and 50,000 CPM to 500,000 CPM. Additional meter damping is automatically applied for the 50 to 500 CPM range to provide steady readings at the low frequencies. This feature is independent of the FILTER-OSC selector setting. The green dot position is used for system TEST.

FILTER TUNING DIAL (Figure 2)

The filter tuning dial indicates, under the dial-window hairline, the frequency to which the filter is tuned, and the oscillator frequency. The dial reads directly in CPM (cycles per minute) with the FREQUENCY RANGE selector set to 50-5000 CPM. For the 500-5K* CPM range, multiply dial readings by 10; for 5K-50K CPM multiply by 100; and for 50K-500K CPM, multiply by 1,000. The dial reading is an indication of the tuned frequency value. However, use the frequency value indicated on the frequency meter as the tuned frequency.

FILTER TUNING CONTROL (Figure 2)

The filter tuning control provides vernier control for both coarse and fine adjustment of the filter tuning dial. For coarse adjustment, the tuning-control dial ratio is 6:1. When the tuning control is turned in the opposite direction, the ratio becomes 36:1 for one turn of the control.

POWER SELECTOR (Figure 2)

The POWER selector disconnects all power from the analyzer circuits in the "OFF" position. In the "AC" position, the instrument is turned on, and power is obtained by connecting the power cable (see figures 3 & 4) to an external 117-volt, 50, 60, or 400-Hz power source. (Internal wiring changes permit 234-volt operation.) In the "AC" position, the batteries receive a trickle charge.

In the BATTERY position, the instrument is also turned on, and power is obtained from the internal batteries.

In the CHARGE position, the internal batteries are charged at maximum rate when the instrument is connected to AC power.

POWER LAMP (Figure 2)

The power lamp indicates when power is being applied to the instrument. The lamp will normally be on whenever the POWER selector is at any position other than "OFF".

*K = 1000 (for example, 5K = 5000)

PICKUP SELECTOR (Figure 2)

The PICKUP selector connects the VIBRATION PICKUP #1 receptacle to the input of the analyzer when set to "1"; or the VIBRATION PICKUP #2 receptacle to the input of the analyzer when set to "2".

SIDE PANELS

All input and output connections to the analyzer are made at the side panels (see figures 3A and 3B.) The left side panel contains the VIBRATION PICKUP #1 and #2 receptacles, the RECORDER receptacles and the SCOPE receptacle. The right side contains the power cable receptacle, an auxiliary AC POWER outlet, the STROB LIGHT receptacle, the power line FUSE and a purge connection

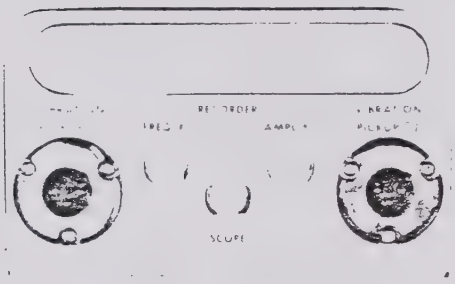


Figure 3A. Left Side Panel

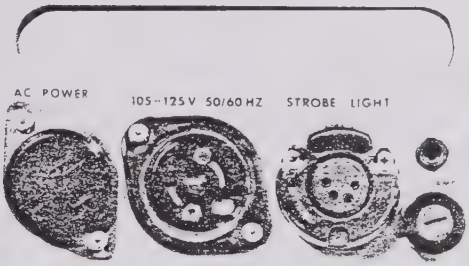


Figure 3B. Right Side Panel

VIBRATION PICKUP #1 RECEPTACLE (Figure 3A)

The VIBRATION PICKUP #1 receptacle receives the connector on the pickup cable from one Mechanalysis Model 544 Vibration Pickup.

VIBRATION PICKUP #2 RECEPTACLE (Figure 3A)

The VIBRATION PICKUP #2 receptacle receives the connector on the pickup cable from a second (optional) Mechanalysis Model 544 Vibration Pickup.

RECORDER AMPLITUDE (Y) RECEPTACLE

A DC voltage output proportional to the analyzer AMPLITUDE meter reading is available at the RECORDER AMPL (Y) receptacle. For a full-scale meter deflection, the voltage is approximately 3 volts. The center pin of the BNC receptacle is positive (+); the shell is negative (-). The receptacle mates with a BNC plug. IRD Mechanalysis XY Recorder, IRD/M Model 1080 is designed to plot this amplitude output on its Y axis. (Most standard X-Y chart recorders with an input impedance of 1 megohm or greater are suitable.) This output may also be used with a strip-chart recorder to obtain a recording of vibration amplitude vs time.

RECORDER FREQ (X) RECEPTACLE

A DC voltage output proportional to the tuned frequency of the filter is available at the RECORDER FREQ (X) receptacle. For a filter dial reading of 500, the voltage is approximately 3 volts. The center pin of the BNC receptacle is positive (+); the shell is negative (-). The receptacle mates with a BNC plug. The required DC recorder input resistance is one megohm. IRD Mechanalysis XY Recorder, Model 1080 is designed to plot this filter dial frequency on its X axis.

SCOPE RECEPTACLE (Figure 3A)

The AC vibration signal is available at the SCOPE receptacle for observation on an oscilloscope. For a full-scale AMPLITUDE meter deflection, the signal voltage is approximately 4 volts rms. The center pin of the BNC connector is the signal wire; the shell is ground.

POWER CABLE RECEPTACLE (Figure 3B)

The power cable receptacle (105-125V 50/60 Hz) receives the twist-lock connector on the AC power cable.

AUXILIARY AC POWER OUTLET (Figure 3B)

The auxiliary AC POWER outlet provides line power for Mechanalysis accessory equipment whenever the instrument is being powered by an external AC power source. The outlet is connected internally to the power cable receptacle. The maximum rating of the auxiliary power outlet is 100 watts.

STROB LIGHT RECEPTACLE (Figure 3B)

The STROB LIGHT receptacle receives the connector on the strob cable from the Model 569 Stroboscopic Light.

STROB CONNECTOR RELEASE (Figure 3B)

When the connector on the strob cable is inserted in the STROB LIGHT receptacle, it is held in place by a spring lock. To remove the strob cable connector, press in on the PUSH tab and pull on the connector.

POWER LINE FUSE (Figure 3B)

The power line FUSE protects the analyzer AC power supply. The fuse is rated at 1/2 ampere, type 3AG, Slo-Blo, Part No. 1511 for 117-volt operation; or 1/4 ampere, type 3AG, Slo-Blo, Part No. 5276 for 234-volt operation

PURGE CONNECTION (Figure 3B)

The purge connection is a 1/8-27 NPT threaded hole provided for air purging of the instrument. A plug seals the hole when not in use; the plug is removed with an allen wrench.

See Analyzer Case Purging on Page 16.

INSTRUMENT CASE AND ACCESSORIES

The 350 instrument is housed in a carrying case of lightweight aluminum with an attractive, tough vinyl coating (see Figure 4). Heavy protective bumpers encircle the case to help prevent damage to the instrument and accessories from shock. The instrument case is not waterproof and can be contaminated by either atmospheric or environmental conditions. See purging instructions on Page 16.

The storage section of the case, Figure 5, provides ample storage for all standard accessories plus additional space for an extra pickup and cable or magnetic holder. The analyzer section and storage section are gasketed for a tight seal when storing the unit.

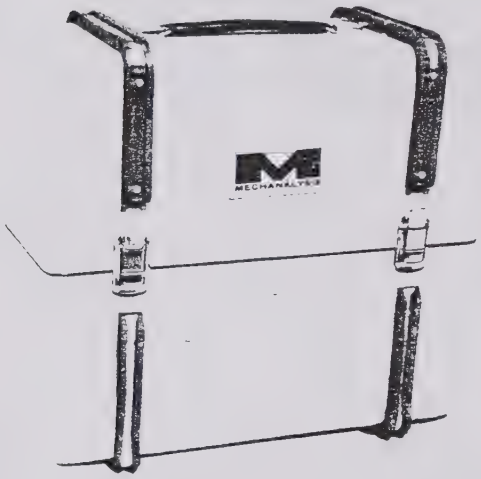


Figure 4. Model 350 Case

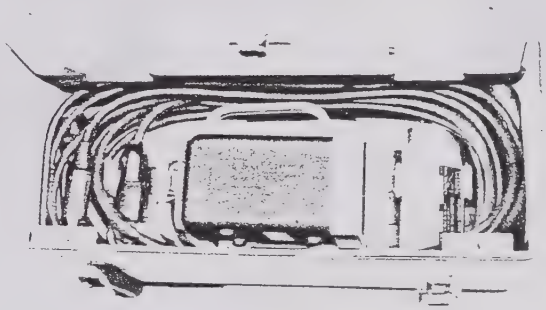


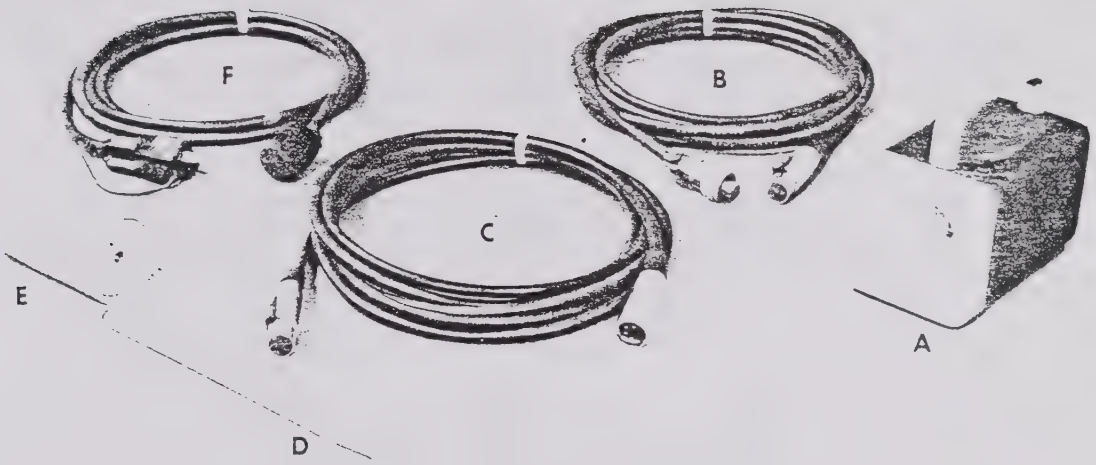
Figure 5. Accessory Storage

MODEL 569 STROBOSCOPIC LIGHT

The Model 569 strob light flashes at a rate equal to the frequency of the measured vibration, or the rate set on the frequency tuning dial when the FILTER-OSC selector is in the "OSC" position. The strob light is used to visually freeze the part of a machine causing the vibration. When used with the "OSC" position on the instrument, the flash rate is adjustable for slow motion studies, strobe-tachometer observations and as an aid for tuning the filter or indicating "phase" for balancing applications. The light has a three (3) position switch; forward is momentary ON, center is OFF, and rear is ON continuous.

The maximum flash rate of the strob light is 15,000 flashes per minute. Vibration frequencies above 15,000 CPM will cause the strob light to flash at sub-multiple rates of the vibration frequency; i.e. 1/2, 1/3, 1/4, 1/5, 1/6, etc. When using the strob light, it is important to remember that the flash rate of the lamp is not normally controlled by the operator, but by the vibration signal. However, when in "OSC" position, the flash rate is adjusted with the tuning knob until the part being studied appears stopped.

When using the unit as a stroboscopic tachometer, with the switch in the "OSC" position, adjust the flash rate of the strob light to its maximum rate (15,000 flashes per minute) by means



A - Model 569 Stroboscopic Light (P/N 8650)
B - 12-foot Vibration Pickup Cable (P/N 4521)
C - 12-foot Strob Cable (P/N 8653)
D - Straight Probe (P/N 1103)
E - Model 544 Vibration Pickup (P/N 4526)
F - 8-foot Power Cable with Adapter (P/N 2914)

Figure 6 Model 350 Standard Accessories

of the tuning knob. Slowly reduce the flash rate until the rotating part under observation appears to be stopped or frozen as a single image. Record this flash rate as R_1. Continue to reduce the flash rate until the part again appears stopped, being very careful not to miss any flash rate at which this occurs. Record this flash rate as R_2. The rotating speed may then be determined as follows:

$$RPM = \frac{R_1 \ R_2}{R_1 - R_2}$$

Example:
By following this procedure, it is determined that a rotating part is visually "frozen" at flash rates of 15,000 flashes per minute and 10,000 flashes per minute.

$$RPM = \frac{15{,}000 \times 10{,}000}{15{,}000 - 10{,}000} = \frac{150{,}000{,}000}{5000} = 30{,}000$$

In this example, the rotating part would also be "frozen" at flash rates of 7500, 6000, 5000, 4286, etc. flashes per minute (every submultiple of 30,000 flashes per minute) and any adjacent pair of readings can be used to determine the speed. For instance, if the 6000 flashes/minute readings were used, the calculation would be:

$$RPM = \frac{6000 \times 5000}{6000 - 5000} = \frac{30,000,000}{1000} = 30,000$$

12' STROB CABLE (Figure 6)

The 12' strob cable connects the Model 569 Strob Light to the [illegible] Belden No. 8424 cable, one Switchcraft No. A5F female connector [illegible] 8617) and one No. A5M male connector (IRD P/N 8615) is used.

12' PICKUP CABLE (Figure 6)

The 12' pickup cable connects the Model 544 Vibratio[illegible] VIBRATION PICKUP No. 1 or No. 2 receptacles located on the [illegible] of the instrument. Belden No. 8428 cable, one Amphenol [illegible] tor (IRD P/N 4637) and one MS3106A-10SL-4S connector (IRD [illegible] AN3057-4A clamp are used.

MODEL 544 VIBRATION PICKUP (Figure 6)

The Model 544 Vibration Pickup senses mechanical vibrat[illegible] it into an electrical signal proportional to the velocity [illegible] It may be used in any position without affecting sensiti[illegible] It is sensitive to vibrations only along its long axis and [illegible] held against a machine or attached permanently using the [illegible] tapped hole. It will withstand temperatures from -40° to [illegible] the "SPECIFICATIONS" section for additional information.

STRAIGHT PROBE (Figure 6)

The straight probe is provided to reach out of the [illegible] screwed into the end of the Vibration Pickup with the [illegible]

POWER CABLE WITH ADAPTER (Figure 6)

The eight-foot power cable is provided for connecting the [illegible] 117-volt (optional 234-volt), 50/60-Hz power supply [illegible] a 2 prong socket adapter.

CAUTION: The green (ground) wire on the adapt[illegible] always be connected to a good electri[illegible] for safe operation.

Specifications

MODEL 350 VIBRATION ANALYZER/DYNAMIC BALANCER

FREQUENCY RANGE

50 to 500,000 cycles per minute (CPM)

FILTER FREQUENCY RANGE

50 to 500,000 CPM in four ranges:
50 to 500; 500 to 5000; 5000 to 50,000; 50,000 to 500,000 CPM

FILTER SELECTIVITY

Broad: Bandwidth 10% Max. of selected frequency at 3db down points (Q = 10)
Sharp: Bandwidth 5% Max. of selected frequency at 3db down points (Q = 20)

INTERNAL OSCILLATOR RANGE

50 to 500,000 CPM in four ranges:
50 to 500; 500 to 5000; 5000 to 50,000; 50,000 to 500,000 CPM

STROBOSCOPIC LIGHT

One flash per cycle to 15,000 CPM; sub–multiple firing to 500,000 CPM

SENSITIVITY (ENGLISH UNITS)

.001 mils (.000,001'') peak–to--peak displacement
.001 inch/second peak velocity

SENSITIVITY (METRIC UNITS)

.03 microns peak–to–peak displacement
.03 millimeter/second peak velocity

DISPLACEMENT RANGE (ENGLISH UNITS)

0 to 100 mils peak–to–peak in 8 overlapping ranges:
0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100 mils (1 mil= .001'')

DISPLACEMENT RANGE (METRIC UNITS)

0 to 3000 microns peak–to–peak in 8 overlapping ranges:
0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 microns

VELOCITY RANGE (ENGLISH UNITS)

0 to 100 inches/second peak in 8 overlapping ranges:
0 to .03; 0 to .1; 0 to .3; 0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100inches/second

VELOCITY RANGE (METRIC UNITS)

0 to 3000 millimeters/second peak in 8 overlapping ranges:
0 to 1; 0 to 3; 0 to 10; 0 to 30; 0 to 100; 0 to 300; 0 to 1000; 0 to 3000 millimeters/second

TEST SIGNAL

Internally generated test signal operates on AC or battery power – checks complete circuit operation.

RECORDER OUTPUTS

DC voltage proportional to amplitude meter and filter dial frequency reading. Approx. 3 volts full scale.

METER DAMPING

Amplitude and frequency meter damping automatically selected by filter frequency range switch.

SCOPE OUTPUT

Vibration signal output for examination on an oscilloscope. Approx. 4 volts RMS with full-scale meter reading.

TEMPERATURE RANGE

0° to 150°F (-18° to +65°C) on AC power
0° to 120°F (-18° to +49°C) on battery power

POWER REQUIREMENTS

(a) 105/129 volts, 50/60/400 Hz, 25 watts (210/258-volt operation obtained by internal jumper change.)
(b) Built-in rechargeable Nickel-Cadmium battery pack:
Instrument batteries - 12 hours continuous operation
Strob batteries - 1 hour continuous operation at maximum flash rate
Battery charging - trickle charge with POWER switch at "AC", fast charge with POWER switch at "CHARGE".

CARRYING CASE

Two deep-drawn aluminum case sections separately contain analyzer and accessories. A rubber gasket on the accessory storage section seals the two sections when latched together, for environmental protection. A rugged carrying handle is installed on the storage section. Heavy rubber bumpers on both sections protect the case and support the sections when together or apart. The case is coated inside and outside with a tough vinyl-base finish. The case is not waterproof and can be contaminated by either atmospheric or environmental conditions. See purging instructions, page 16.

OVERALL DIMENSIONS

Analyzer section: 7-1/2" x 10" x 15-1/2" (19cm x 25cm x 39cm)
Storage section: 7-1/2" x 8" x 15-1/2" (19cm x 20cm x 39cm)
Both sections (latched together): 7-1/2" x 15-1/2" x 15" (19cm x 39cm x 38cm)

WEIGHT

Analyzer section with battery pack - 19 lbs. (8.6 Kgm)
Complete unit (with standard accessories) - 30 lbs. (13.6 Kgm)
Shipping weight (approximate) - 45 lbs. (20.4 Kgm)

ACCESSORIES
STANDARD EQUIPMENT FURNISHED WITH THE MODEL 350

1 - Model 544 Vibration Pickup (Part No. 4526)
1 - 12' Pickup Cable (Part No. 4521)
1 - Model 569 Stroboscopic Light (Part No. 8650)
1 - 12' Stroboscopic Light Cable (Part No. 8653)
1 - Straight Probe (Part No. 1103)
1 - 8' Power Cable with Adapter (Part No. 2914)

OPTIONAL EQUIPMENT

Retractable Pickup Cable with connectors (6 ft. extended, 1 ft. retracted) Part No. 4523
25-feet Pickup Cable with connectors (Part No. 4690)
50-feet Pickup Cable with connectors (Part No. 4691)
75-feet Pickup Cable with connectors (Part No. 5202)
100-feet Pickup Cable with connectors (Part No. 4692)
25-feet Strobe Light Cable with connectors (Part No. 8720)
Magnetic Shield for Model 544 Pickup, 100:1 shielding, (Part No. 10449
Magnetic Shield for Model 544M Pickup, 100:1 shielding, (Part No. 10140)
Vise-Grip Pickup Holder for use with Model 544 Pickup (Part No. 1821)
Shaft Stick for use with Model 544 Pickup (Part No. 2475)
Model 546 DP Vibration Pickup; Direct Prod; Low Frequency (Part No. 2785)
Non-Contact Displacement Accessory (Part No. 5346) for shielded type pickup
Non-Contact Displacement Accessory - 2 Channel (Part No. 9252) for non-shielded type pickup
Sound Level Meter Accessory (Model 308)
Multiple Selector Accelerometer Accessory (Part No. 10312)
X-Y Recorder (Model 1080) including power cable and carrying case (Part No. 12779), see Specifications on Page 48.
Recorder Paper, Model 350 Data Sheets "Machinery Vibration Signatures" - Pad of 25 sheets (Part No. 10601)
Replacement Bulb for Strobe Light (Part No. 8461)
Vibration Pickup and System Tester (Model 421)

MODEL 544 VIBRATION PICKUP

SENSITIVITY

240 millivolts RMS ±10% for .001" peak-to-peak displacement @100Hz corresponding to velocity of 1.08 volts peak per inch per second. Sensitivity is unaffected by orientation.

ORIENTATION

Pickup may be used in any mounting position without adjustment or correction.

FREQUENCY RESPONSE

Room ambient (+77°F); ±8% over the frequency range 12 - 1000 Hz; down 8%±13% @10 Hz. Pickup frequency response drops exponentially at lower frequencies. Elevated ambient (+250°F); ±13% over the frequency range 12-1000 Hz. The above limits are total variations for any mounting position of the pickup.

NATURAL RESONANT FREQUENCY

16 Hz, critically damped at +77°F

DAMPING CHARACTERISTICS

The pickup has a damping factor of approximately .7 which results in essentially flat operation over the frequency range. This provides improved accuracy and improved transient response for low frequency operations.

TEMPERATURE RANGE

-40°F to 500°F (-40°C to 260°C)

IMPEDANCE

Approximately 2000 ohms D.C. resistance, ±10%

AMPLITUDE RANGE

Minimum: Limited only by amplifier gain and noise level.
Maximum: .125 inches peak-to-peak up to 70 Hz; above 70 Hz, maximum shake is 30 g's.
Transverse Response: Average response less than 5% over the frequency range 10-1000 Hz.

AMPLITUDE LINEARITIES

±5% from .0001 to .1000 inches peak-to-peak displacement

RECOMMENDED MAX. ACCELERATION

2.5 g's at 20 Hz to 30 g's above 70 Hz continuous

MAGNETIC FIELD SENSITIVITY

Without shielding - .14 in/sec/gauss @ 60 Hz
With 100:1 shielding (Part No. 10449) - .0015 in/sec/gauss @60 Hz (Model 544 Pickup)
With 100:1 shielding (Part No. 10140) - .0015 in/sec/gauss @60 Hz Model 544M Pickup)

POWER REQUIRED

The pickup is a self-generating unit and requires no external power source.

CONSTRUCTION

High-temperature solder connections
Case-machined aluminum

CONNECTOR

Cannon, G502-1052-4P-111, hermetically sealed (Part No. 8730), Gasket (Part No. 8731).

WEIGHT AND DIMENSIONS

4-7/8" L x 2-3/16" Dia.
Weight - 21 ounces

MOUNTING

One 1/4"-28 x 1/4" tapped hole for mounting to suitable bracket. May be hand-held for probing studies.

WATER RESISTANCE

The pickup cases and connector are water resistant. Pickup performance is not affected by short periods of exposure to high humidity, condensation, or immersion in water.

Preparation Procedure

To prepare the Model 350 Vibration Analyzer for operation, proceed as follows:

1. Screw the straight probe into the Model 544 Pickup, or attach the pickup to the machine using a Vise Grip holder, Magnetic Holder, or threaded stud.

2. Connect one end of the pickup cable to the 544 Pickup and the other end to either pickup receptacle at the left side of the analyzer. A second Model 544 Pickup may be similarly connected. Set the PICKUP SELECTOR to "1" or "2" to connect the #1 or #2 pickup respectively to the input of the analyzer.

3. Connect one end of the strob light cable to the strob light and the other end to the strob receptacle at the right side of the analyzer.

POWER LINE OPERATION

1. Connect the power cable to the power cable receptacle and to a 117-volt, 50/60-Hz outlet (or 234-volt for instruments so wired). If the power outlet is for a two-prong receptacle, use the power cable adapter provided and connect the green adapter wire to a good electrical ground. Set the POWER selector to "AC". The power lamp should light, indicating that power is being applied to the instrument.

2. Circuit Operation Checks: Set selectors to the four green dot positions as follows:

   a) Set the DISP-VEL selector to "DISP".

   b) Set the AMPLITUDE RANGE selector to "TEST".

   c) Set the FREQUENCY RANGE selector to "500-5K".

   d) Set the FILTER-OSC selector to "OUT".

   A meter reading within the green test area on both the AMPLITUDE meter and the FREQUENCY meter indicates normal circuit operation.

   e) Set the FILTER-OSC selector to "SHARP".

   f) Tune the filter tuning dial through a reading of 400 and note that the AMPLITUDE meter reading peaks when the dial reads approximately 400.

   With the AMPLITUDE meter reading tuned to a peak, a meter reading within the green test area on both the AMPLITUDE meter and the FREQUENCY meter indicates normal FILTER-SHARP operation.

   g) Repeat step f with FILTER-OSC set to "BROAD".

   With the AMPLITUDE meter reading tuned to peak, a meter reading within the green test area on both the AMPLITUDE meter and the FREQUENCY meter indicates normal FILTER-BROAD operation.

   h) Set the FILTER-OSC selector to "OSC". The Model 569 Stroboscopic Light has a three-position switch which is OFF in its center position. The rear position switches the strob light ON; the forward position is spring-loaded and switches the strob light ON as long as it is held forward. With the switch in either ON position, the strob light should flash at a rate indicated by the filter tuning dial and the FREQ RANGE selector, up to 15,000 CPM. Above 15,000 CPM, the light will flash at a sub-multiple of the indicated frequency.

BATTERY OPERATION

IMPORTANT–Rechargeable batteries lose their charge over a period of a few weeks, even if the instrument is not in use. To be assured of the maximum operating time, operate the instrument in the CHARGE mode for 16–18 hours prior to use (See Maintenance Section of manual)

1. Set the POWER selector to "BATTERY". The power lamp should light, indicating that power is being applied to the instrument.

2. Battery Check:
   a) Set the AMPLITUDE RANGE selector to "TEST".
   b) Set the DISP–VEL selector to "DISP".
   c) Set the FILTER–OSC selector to "OUT".
   d) Set the FREQ RANGE selector to "500–5K".

   The AMPLITUDE and FREQUENCY meters should indicate in the center of the green test areas, or above. If either meter reads below, the batteries are not fully charged.

3. Perform the Circuit Operation Checks as previously given for "Power Line Operation".

4. Strob Operation on Battery.
   a) Set the POWER switch to "BATTERY" and check as in Step 2 (h) for "Power Line Operation". Use of the spring return position on the strob switch will conserve strob battery power.

      NOTE: Whenever the strob light has been operated on battery power, the batteries should be recharged. (See "Maintenance–Recharging Batteries".)

ANALYZER CASE PURGING

The PURGING connection is provided for flushing and pressurizing the instrument case with clean air or a dry, inert gas, to exclude harmful gases, dusts, and vapors which may be present in some environments. Purging air may be obtained from an instrument air supply. Shop air must be thoroughly filtered to remove water, oil, and dirt particles.

To use the purging connection, remove the plug and install a 1/8" NPT fitting to a 0–50 psi regulator connected to the air supply. A pressure of 10–30 psi into the instrument case is sufficient to flush the case and maintain a slight positive pressure inside the case. (Air will flow out through various openings in the front panel and end plates).

CAUTION

Do not exceed 50 psi. Purge the case for 15 minutes before turning the instrument on.

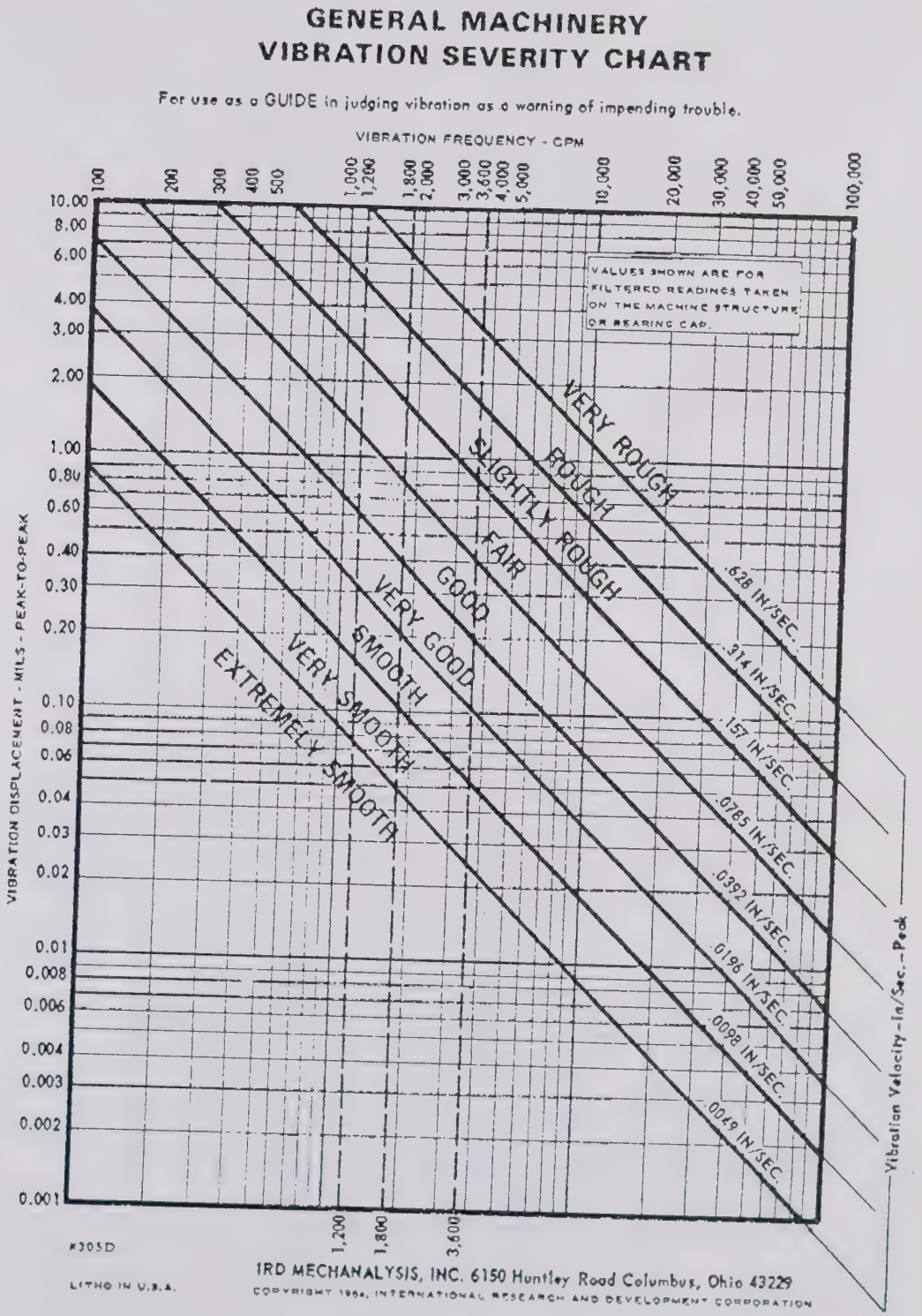


Figure 8A Vibration Severity Chart in Mils

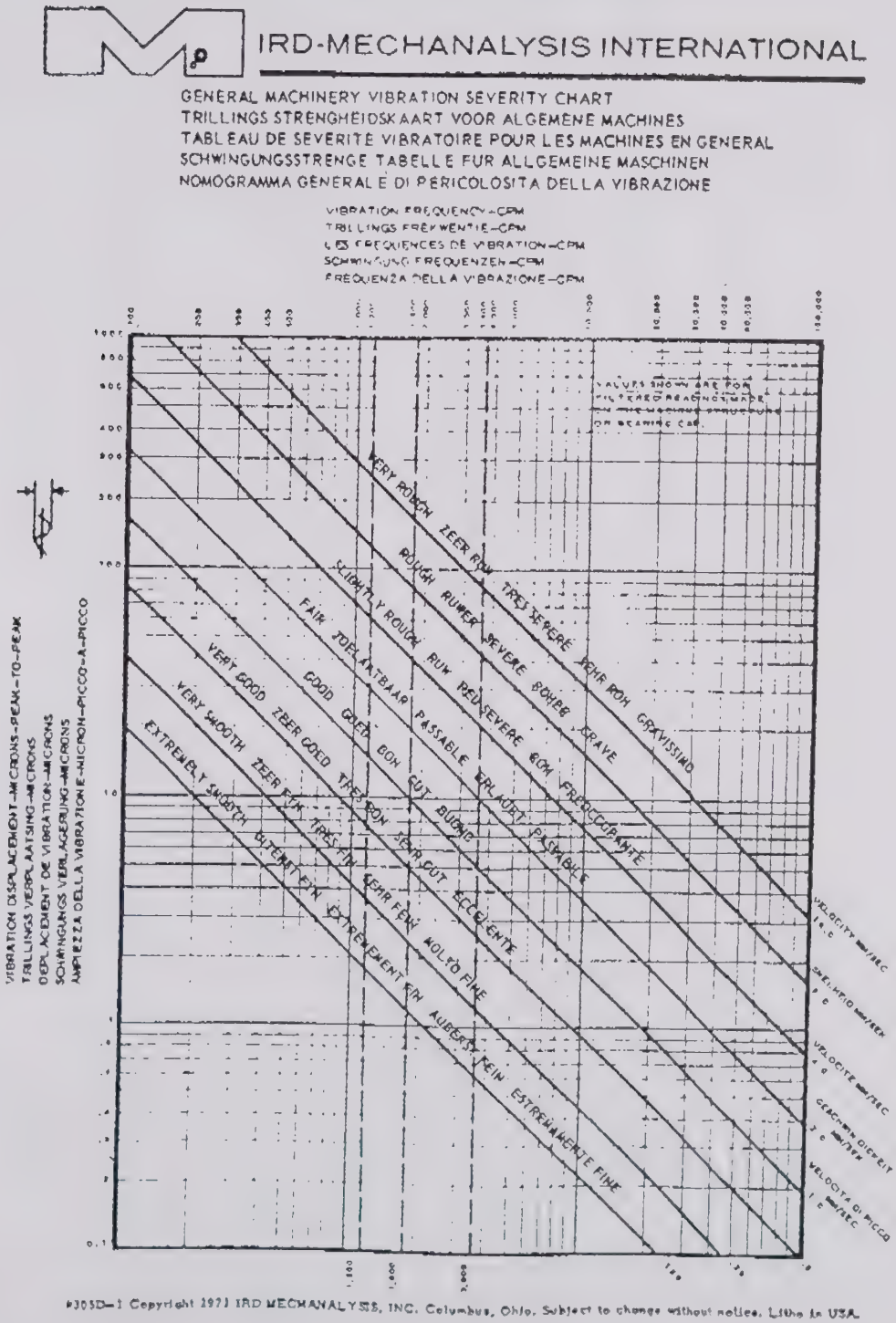

IRD-MECHANALYSIS INTERNATIONAL
GENERAL MACHINERY VIBRATION SEVERITY CHART
TRILLINGS STRENGHEIDSKAART VOOR ALGEMENE MACHINES
TABLEAU DE SEVERITE VIBRATOIRE POUR LES MACHINES EN GENERAL
SCHWINGUNGSSTRENGE TABELLE FUR ALLGEMEINE MASCHINEN
NOMOGRAMMA GENERALE DI PERICOLOSITA DELLA VIBRAZIONE
VIBRATION FREQUENCY—CPM
TRILLINGS FREQUENTIE—CPM
LES FREQUENCES DE VIBRATION—CPM
SCHWINGUNG FREQUENZEN—CPM
FREQUENZA DELLA VIBRAZIONE—CPM
VALUES SHOWN ARE FOR FILTERED DIAGNOSTIC MADE IN THE MACHINE STRUCTURE OR BEARING CAP.
VERY ROUGH ZEER RUW TRES SEVERE MUY SEVERE BOUBE GRAVE
ROUGH RUWER SEVERE RUW SEVERE BOM GRAVISSIMO
SLIGHTLY ROUGH FAIR TOELAATBAAR PASSABLE ERLAUBT PASSABLE
GOOD GOED BON CUT BUONO
VERY GOOD ZEER GOED TRES BON TRES BON ECCELENTE
VERY SMOOTH ZEER FIJN TRES FIN SEHR FEIN MOLTO FINE
EXTREMELY SMOOTH UITERST FIJN EXTREMEMENT FIN AUBERST FEIN ESTREMAMENTE FINE
VIBRATION DISPLACEMENT—MICRONS—PEAK-TO-PEAK
TRILLINGS VERPLAATSING—MICRONS
DEPLACEMENT DE VIBRATION—MICRONS
SCHWINGUNGS VERLAGERUNG—MICRONS
AMPIEZZA DELLA VIBRAZIONE—MICRON—PICCO-A-PICCO
VELOCITY MM/SEC
VELOCITE MM/SEC
VELOCITA DI PICCO
#305D—1 Copyright 1971 IRD MECHANALYSIS, INC. Columbus, Ohio. Subject to change without notice. Litho in USA.

Figure 8B Vibration Severity Chart in Microns

VIBRATION IDENTIFICATION

CAUSE	AMPLITUDE	FREQUENCY	PHASE	REMARKS
Unbalance	Proportional to unbalance. Largest in radial direction.	1 x RPM	Single reference mark.	Most common cause of vibration.
Misalignment couplings or bearings and bent shaft	Large in axial direction 50% or more of radial vibration	1 x RPM usual 2 & 3 x RPM sometimes	Single double or triple	Best found by appearance of large axial vibration. Use dial indicators or other method for positive diagnosis. If sleeve bearing machine and no coupling misalignment balance the rotor.
Bad bearings anti-friction type	Unsteady - use velocity measurement if possible	Very high several times RPM.	Erratic	Bearing responsible most likely the one nearest point of largest high-frequency vibration.
Eccentric journals	Usually not large	1 x RPM	Single mark	If on gears largest vibration in line with gear centers. If on motor or generator vibration disappears when power is turned off. If on pump or blower attempt to balance.
Bad gears or gear noise	Low - use velocity measure if possible	Very high gear teeth times RPM	Erratic	
Mechanical looseness		2 x RPM	Two reference marks. Slightly erratic.	Usually accompanied by unbalance and/or misalignment.
Bad drive belts	Erratic or pulsing	1, 2, 3 & 4 x RPM of belts	One or two depending on frequency. Usually unsteady.	Strob light best tool to freeze faulty belt.
Electrical	Disappears when power is turned off.	1 x RPM or 1 or 2 x synchronous frequency.	Single or rotating double mark.	If vibration amplitude drops off instantly when power is turned off cause is electrical.
Aerodynamic hydraulic forces		1 x RPM or number of blades on fan or impeller x RPM		Rare as a cause of trouble except in cases of resonance.
Reciprocating forces		1, 2 & higher orders x RPM		Inherent in reciprocating machines can only be reduced by design changes or isolation.

COPYRIGHT 1960 INTERNATIONAL RESEARCH AND DEVELOPMENT CORPORATION

D 393

Figure 9 Vibration Identification Chart

IRD MECHANALYSIS, INC. **DATA SHEET** DATE _____

☐ NOISE ☐ VIBRATION ANALYSIS OF: _____

FOR: _____

MECHANALYSIS EQUIPMENT USED: _____

PERFORMED BY: _____

TEST CONDITIONS:

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

PICKUP		FILTER OUT						FILTER IN					
		NOISE		DISPL.		VELOCITY							
POINT	POS.	dB(A)	CPM	MILS	CPM	IN/SEC	CPM						
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												
	H												
	V												
	A												

Figure 7 Vibration History Form

e) Using the tuning dial control, adjust the flash rate to "freeze" the mark. That is, the mark should appear to stand still in one position.

f) Set the FILTER-OSC selector to "SHARP" and retune as necessary. The filter is now tuned to the rotating speed of the part.

8. By placing the vibration pickup at each bearing housing of a machine, a record of the machine vibration can be obtained. Figure 7 shows a form used to record vibration data. Note that both FILTER OUT (overall) and FILTER IN readings are obtained from each bearing housing in the horizontal, vertical and axial directions.

NOTE: Figure 8 is a general guide for determining if a vibration is excessive and requires correction.

9. After the vibration has been measured and recorded, determine the nature of the trouble causing the vibration. Figure 9 lists the vibration characteristics for a variety of machinery troubles. This chart can be used to identify the causes of the measured vibration.

BALANCING

Unbalance is probably the most common cause of machinery vibration. The Model 350 can be used to balance a part in-place as follows:

1. Mark the end of the shaft with chalk or suitable material for use as a balancing reference mark. Any distinctive point (such as a keyway) can be used. If chalk is used, mark the end of the shaft from the center out.

2. Attach or hold the pickup to the point chosen near the vibrating part with the greatest displacement. Use the horizontal or vertical direction, whichever gives the highest reading. Be sure the locations and positions of the pickup are the same throughout the balancing procedure.

3. Start the machine and allow it to come up to normal operating speed.

4. Tune the analyzer filter to the speed of the part being balanced by using one of the filter tuning techniques described previously.

5. Visualize the rotor as a clock face. Read the position of the reference mark as though it were a clock hand. Record the position of the reference mark (9:00, 2:00, etc.). Record the vibration amplitude as read from the AMPLITUDE meter. This is the original reading. In the example, Figure 10, the original reading "0" = 6.6 mils @ 5:00.

6. Stop the machine and add a trial weight at any location on the rotor.

CAUTION

Attach trial weights securely

7. Restart the machine and allow it to come up to operating speed. Check the filter and be sure it is still properly tuned. Record the new amplitude reading and the new position of the reference mark. This is called the "O+T" (original + trial weight) reading. In Figure 11,) + T = 6.7 mills @ 9:00.

Peak Method

a) Switch the FILTER–OSC selector to the "BROAD" position.

b) Switch the FREQUENCY RANGE selector to the range which includes the frequency equal to the machine speed. (Example: Machine speed = 1800 RPM: therefore, set FREQ RANGE to "500–5K").

c) Set the filter tuning dial until the approximate machine speed is under the hairline. Adjust the AMPLITUDE RANGE selector to obtain a meter reading in the upper third of the AMPLITUDE meter scale.

d) Using the filter tuning control, tune the filter just past the peak AMPLITUDE meter reading. Switch the FILTER–OSC selector to "SHARP". Reverse the rotation of the tuning control and slowly adjust the filter for a peak AMPLITUDE meter reading. If the meter indication decreases, turn the dial the opposite direction and slowly adjust the dial until the highest reading on the AMPLITUDE meter is obtained. Change the AMPLITUDE RANGE as required to keep the reading in the upper third of the AMPLITUDE meter scale.

e) Read the vibration amplitude indicated on the AMPLITUDE meter. Read the frequency of the vibration on the FREQUENCY meter. Be sure to interpret frequency reading correctly, as determined by FREQ RANGE position. (Example: FREQUENCY meter reads 50, with FREQ RANGE at "5K–50K"; interpret reading as 5K, i. e., 5000 CPM.)

f) The filter may be tuned to each vibration present in the same manner. The filter may also be used to "scan" through the entire frequency range just as you might search a radio tuning dial for unknown stations. Turn the tuning control slowly to allow the instrument time to react. At the same time adjust the AMPLITUDE RANGE selector for an up–scale indication on the AMPLITUDE meter.

NOTE: Use the "BROAD" position when scanning for vibrations with filter. For maximum filtering tune to a peak using the "BROAD" filter first, then readjust to a peak using the "SHARP" filter.

Strob Light Method

a) Switch the FILTER–OSC selector to the "OSC" position.

b) Switch the FREQ RANGE selector to the range which includes the frequency equal to the machine speed.

c) Turn the filter tuning control until the approximate machine speed is indicated under the hairline on the filter tuning dial window.

d) Direct the Strob Light to illuminate the rotating shaft. A reference mark on the part (Keyway or chalk mark) will appear to rotate slowly under the Strob Light.

VIBRATION MEASUREMENT

1. Prepare the Model 350 for operation on either AC power or internal batteries.

2. Turn the FILTER-OSC selector to the "OUT" position.

3. Select either displacement or velocity measurement with the DISP-VEL switch.

   NOTE: Vibration displacement is normally used for frequencies of vibration up to 1200 CPM; above 1200 CPM vibration velocity is recommended.

4. Place the vibration pickup on the bearing housing of the rotating equipment being analyzed.

5. Starting with the AMPLITUDE RANGE selector at "100" (mils or inches/second), turn the selector clockwise until a reading of at least 1/3 full-scale is obtained on the AMPLITUDE meter. This reading is the overall vibration at the point where the pickup is applied.

The AMPLITUDE meter has two sets of graduations - the top from 0 to 1; the bottom from 0 to 3. The setting of the AMPLITUDE RANGE selector determines which set of graduations apply. If this setting is 100, 10, 1 or .1 use the top graduations when reading the meter, placing the decimal point as indicated by the AMPLITUDE RANGE selector. Thus on the 100 setting, full-scale on the AMPLITUDE meter becomes 100 mils (or in/sec); .6 on the meter becomes 60 mils (or in/sec); etc. If the AMPLITUDE RANGE selector is set on 30, 3, .3 or .03 use the bottom graduations, placing the decimal point in the same way.

6. Direct the strob light on the various rotating components of the equipment being analyzed. The part causing the predominant vibration will trigger the light in synchronization with its rotating speed and will appear to be stopped under the strob light. Also, in "Filter Out" the FREQUENCY meter can indicate the predominant frequency of vibration. However, the meter reading is very dependent on the relative amplitude and frequency of all input signal components. The meter circuit senses all positive-going zero crossovers and supplies a unit of current to the meter for each crossover. Thus, in "Filter Out", the FREQUENCY meter will read either the predominent vibration frequency or a multiple of this frequency.

VIBRATION ANALYSIS

7. Normal machinery vibration is generally complex, consisting of several frequencies from different sources. Vibration analysis is the procedure of determining the amount and frequency of each vibration present and relating these characteristics of vibration to what is known about the machine to pintpoint the source(s).

   To determine the frequency characteristics of the overall vibration, the filter in the instrument may be tuned to the vibration occuring at each frequency much as a radio is tuned to individual stations.

   Normally, machinery vibrations occur at frequencies of 1, 2, 3, 4 and sometimes higher multiples of the rotating speed of the part causing the trouble. A check of the machine name plate speeds will be helpful in determining at which frequencies vibration is likely. There are two methods you can use to tune the filter:

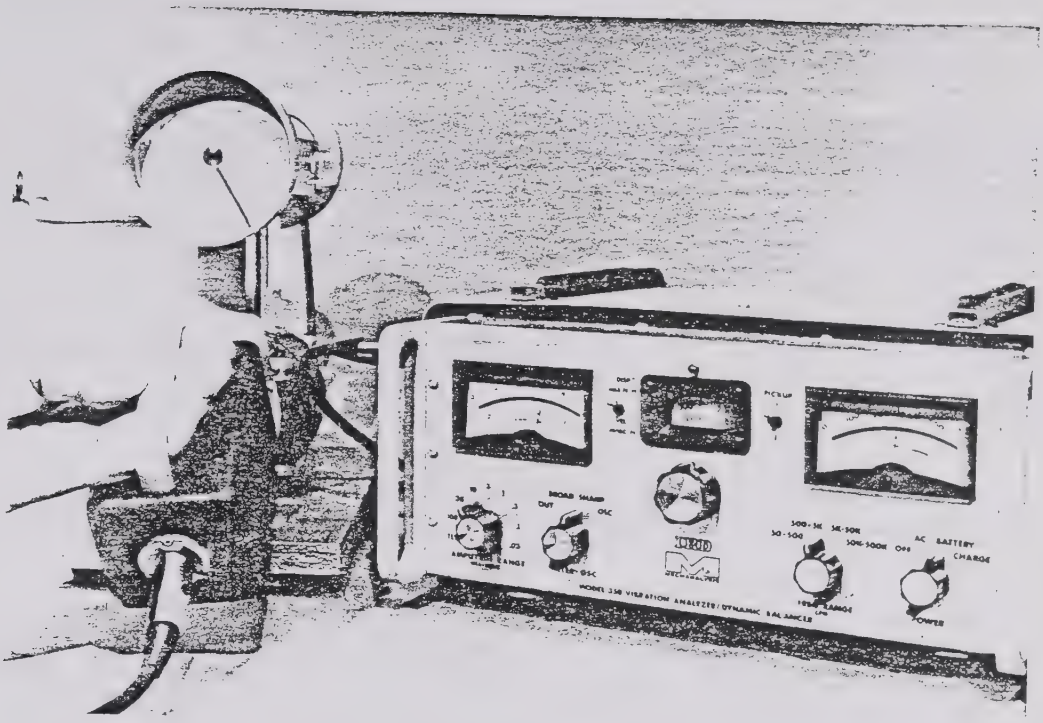


Figure 10. Original Unbalance Readings

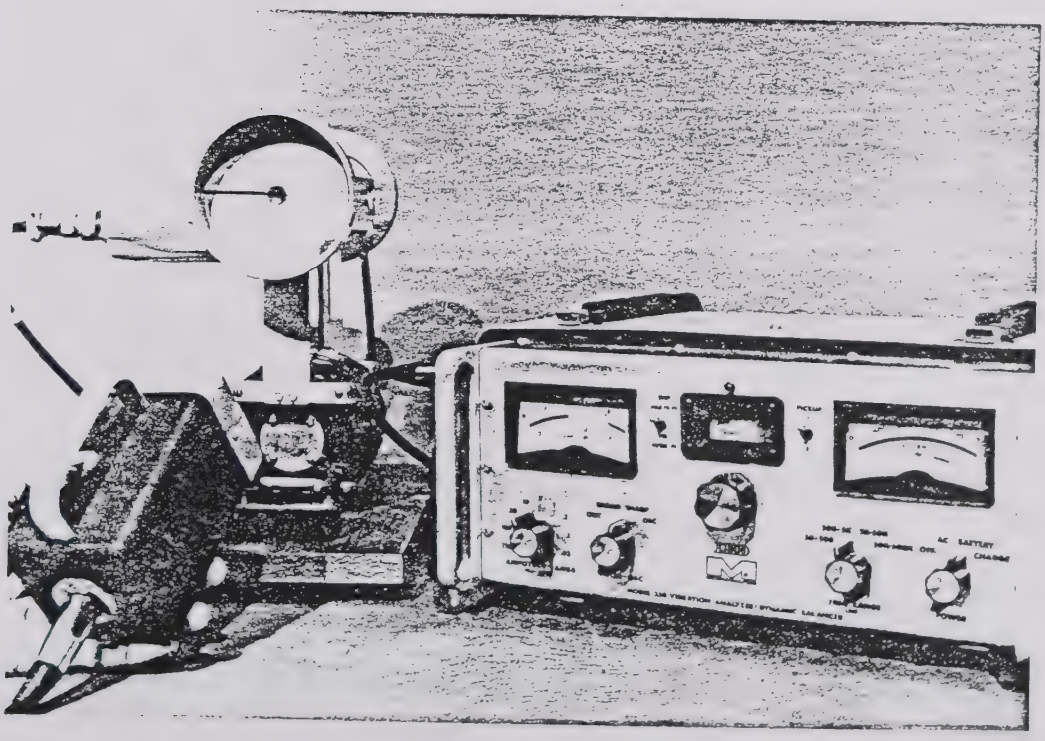


Figure 11. Reading With Trial Weight ("O + T")

Either of two methods for determining the exact amount and location of unbalance can be used - the Trial Method and the Vector Method.

Trial Method: Actually only a few combinations of amplitude and phase (reference mark) changes can result from adding a trial weight. In the trial method balancing, this information is used continually to refine the amount and position of the trial weight until it is nearly equal and opposite the heavy spot on the workpiece. To use the trial method, apply and reapply the fundamentals of the chart in Figure 12 until an acceptably low level is reached.

RECHECK FILTER SETTING BEFORE EACH READING

ALWAYS COMPARE THE NEW READINGS TO THE ORIGINAL READING.

Vector Method: The vector method of balancing will nearly always require fewer balancing runs than the trial method. The steps are as follows:

a) Draw a line on a sheet of polar coordinate graph paper at the same angle as the original reference mark, with a length proportional to the original amplitude. Use any convenient scale. Call this line (vector) "0". See Figure 13.

b) In a similar manner, plot the "0 + T" reading to the same scale as in Step a. Label this line "0 + T" as shown in Figure 13.

c) Draw a line from the end of line "0" to the end of line "0 + T" and label as line "T".

d) The angle, measured with a protractor, between line "0" and line "T" is the angle the trial weight should be shifted. The weight should be shifted the opposite direction of the reference mark shift. In the example, Figure 13 it is shown that the angle between "0" and "T" is 30°. The reference mark shifted from the original 5:00 position to the 9:00 position which represents a clockwise reference shift. Therefore, the trial weight must be moved 30° counterclockwise from the original trial weight position.

e) Determine the correct amount of weight to be applied to the rotating part by multiplying the ratio of the length of line O to the length of line T by the trial weight:

$$\text{Correct Wt.} = \text{Trial Wt.} \times \frac{O}{T}$$

For the example above, assume the trial weight is 5 ounces. Line T measured to the same scale = 11.5. Therefore:

$$\text{Correct Weight} = \text{Trial Weight} \times \frac{O}{T}$$

$$= 5 \text{ ounces} \times \frac{6.6}{11.5}$$

$$= 2.87 \text{ ounces}$$

f) Because the diagram cannot be 100% accurate and the length of the lines cannot correspond perfectly to the amplitude reading additional runs may be required to balance to required tolerances.

NOTE: For detailed instruction and further information on balancing refer to the text "Vibration Analysis & Dynamic Balancing" available to those who have attended IRD MECHANALYSIS, INC. Audio-Visual Training Program. Details on IRD MECHANALYSIS, INC. training programs are available by contacting the nearest representative or writing to IRD MECHANALYSIS, INC., Columbus, Ohio 43229.

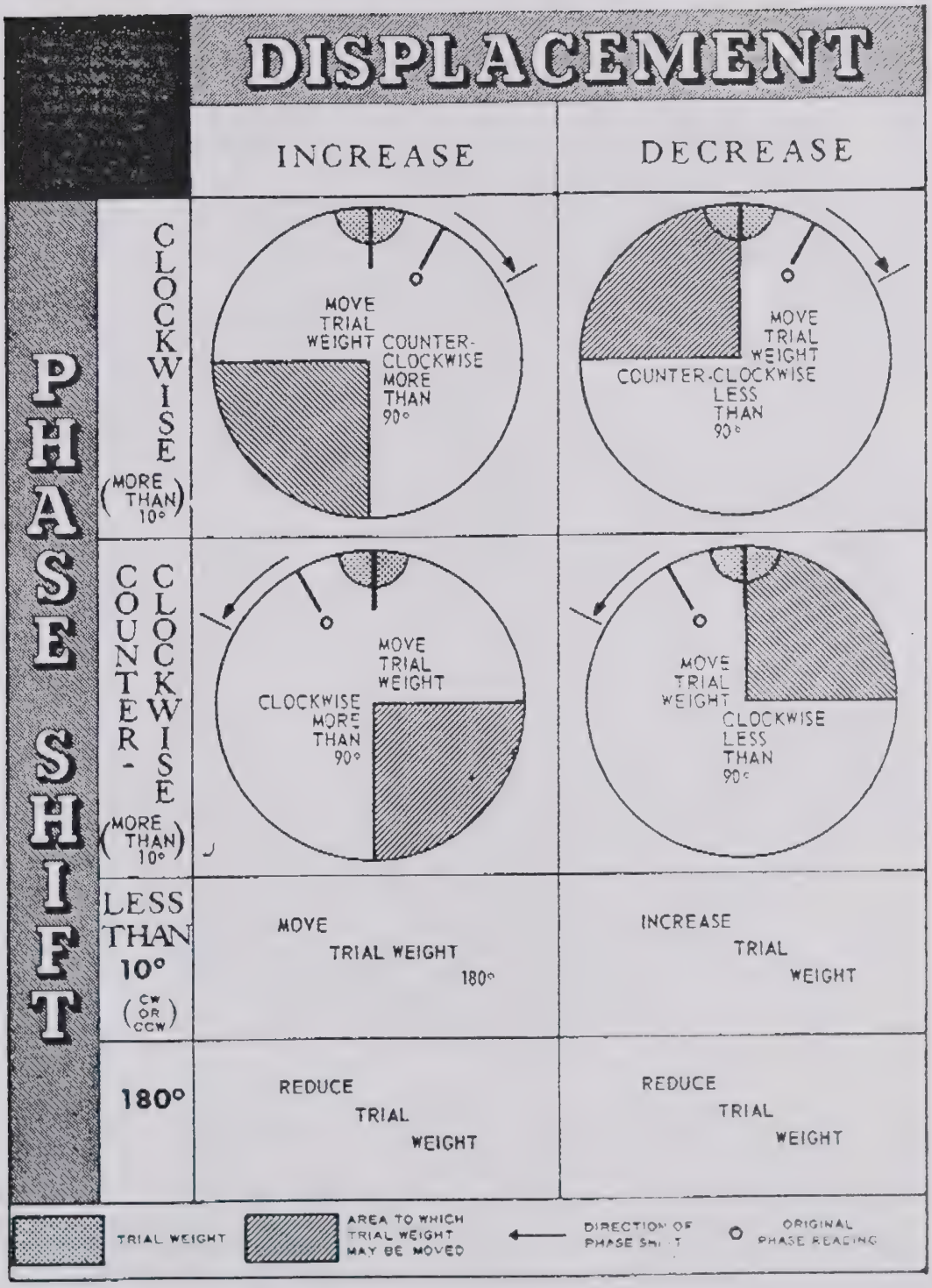


Figure 12. Fundamental Rules of Balancing

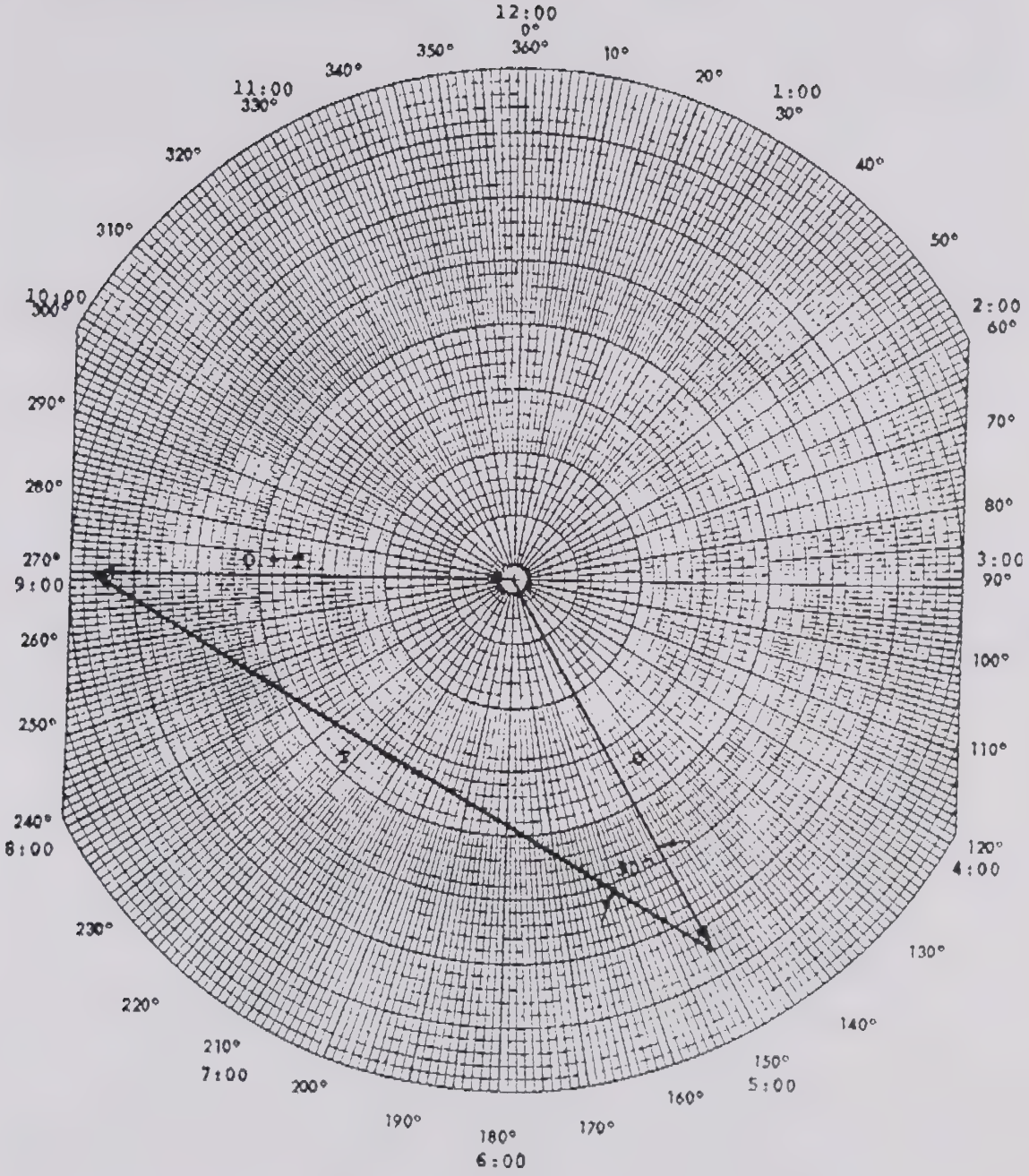


Figure 13. Simplified Vector Diagram

OBTAINING MACHINERY VIBRATION SIGNATURES

In carrying out a Preventive Maintenance Program, complete and accurate machine vibration data must be obtained quickly. When operational data, such as vibration readings, are recorded to provide study material for a given machine operation, the recordings must be examined thoroughly to provide the information needed for pinpointing problems in the machine. Generally, plotting the Vibration Amplitude - vs - Frequency provides a complete picture of all frequency components present in the machine vibration. This plotting greatly simplifies identifying the vibrations.

The Model 350 Vibration Analyzer provides the signals for generating "hard-copy" machine vibration "signatures". The 350 FREQ (X) and AMPL (Y) outputs provide DC signals proportional to the filter-tuned frequency and vibration amplitude readouts. Receptacles for these two outputs connect to the horizontal (FREQUENCY) and vertical (AMPLITUDE) cables of the X-Y Recorder (see Figs. 14A and B). The vibration "signature" is then generated by manually tuning the 350 filter through the desired frequency range. A typical vibration "signature" is shown in Figure 14C.

Vibration signatures are easily interpreted, and they provide a mechanical condition record of the machine. Signatures can be obtained quickly, and they provide invaluable information for a Preventive Maintenance Program. A given signature can be dated and later on used as a baseline for interpreting new signatures of the same machine. Comparing the two signatures can be helpful in diagnosing trouble or in proving that the mechanical condition of the machine has not changed.

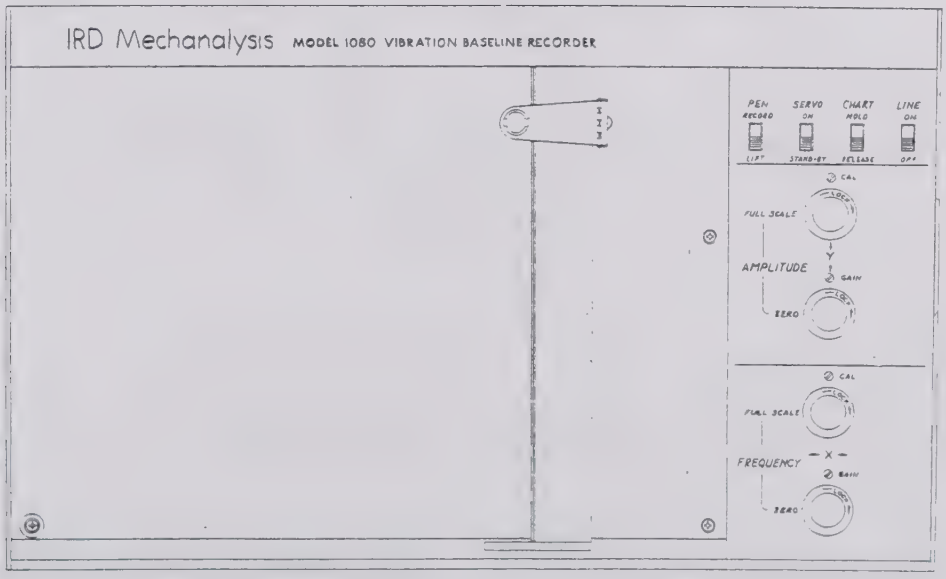


Figure 14A X-Y Recorder, Model 1080, Illustration

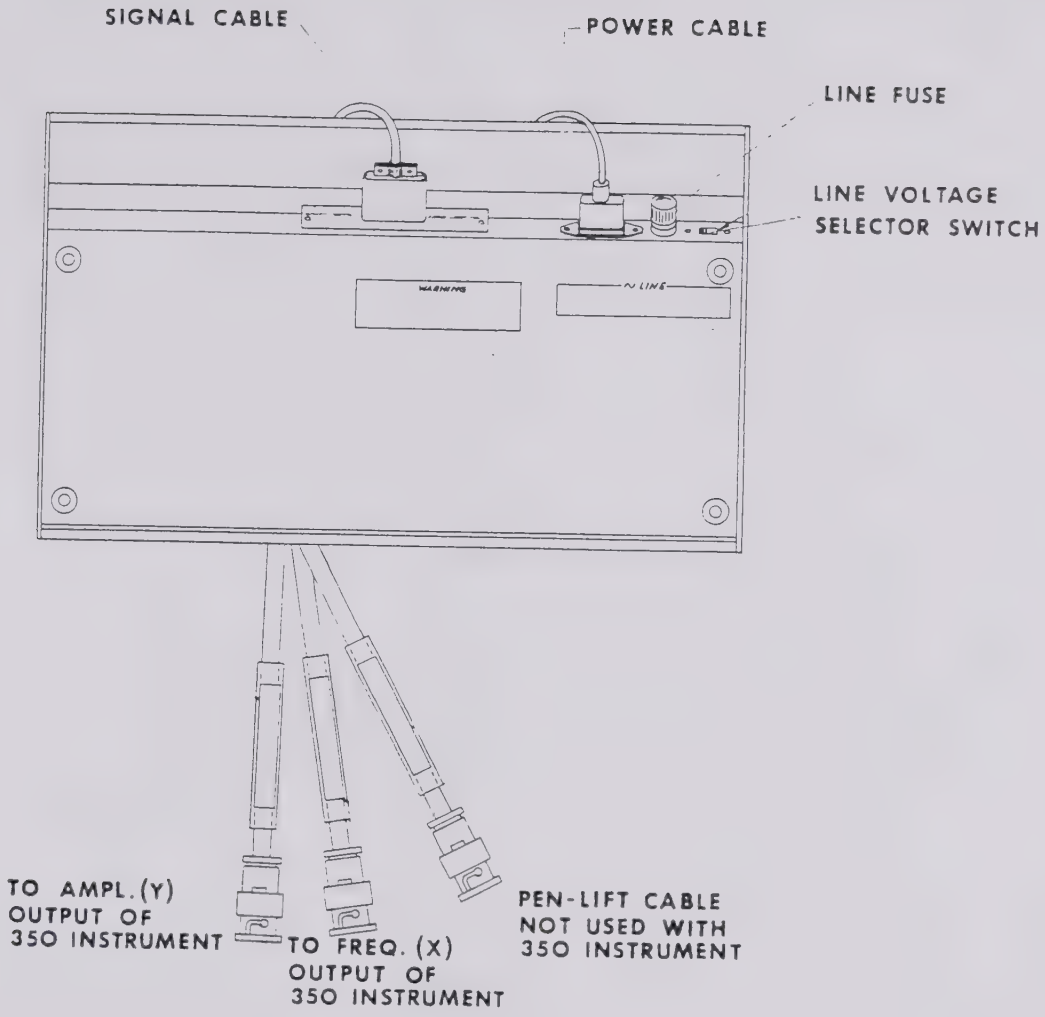


Figure 14B X-Y Recorder Bottom View Showing Cables and Inputs

The Power and 3-section Signal Input cables are supplied with the X-Y Recorder. For 117 Vac supply voltage, use a 1/4-ampere fuse (P/N 5276), but for 234 Vac supply voltage use a 1/8-ampere fuse (P/N 5945). Also, set the "Line Voltage Selector" switch to the position corresponding to the line voltage value.

CAUTION: Operating with the wrong size power fuse or with the Line Voltage Selector switch in the wrong position may damage the Recorder.

X-Y RECORDER SETUP INSTRUCTIONS

1. Set up the 350 Vibration Analyzer instrument for analysis as instructed on Page 15 of this manual, then disconnect the vibration pickup.

NOTE: The optional X-Y Recorder, Model 1080, is equipped with interconnecting cables for the power-line supply voltage, the FREQUENCY (X) and the AMPLITUDE (Y) signals from the 350 instrument. These cables are attached to receptacles at the bottom of the recorder.

2. Set the X-Y Recorder control switches to POWER OFF, PEN UP, and CHART RELEASE.

3. Connect the power-line cable to the correct supply voltage, see Page 3-1 of the recorder manual for details.

4. Connect the FREQUENCY (X) and AMPLITUDE (Y) recorder cables to the corresponding receptacles on the 350 instrument.

NOTE: The PEN LIFT cable is not used with the 350 instrument.

5. Insert the recorder pen in the carriage holder after removing the pen cover, see page 3-4 of the recorder manual for details.

6. Set up the 350 Analyzer controls as follows: Amplitude Range selector to "100", Filter-Osc selector to "Out", Displ/Vel switch to "Displ", Pickup switch to "1" or "2", depending on the channel to be used, Freq. Range selector to "500-5K", and Power selector to "AC".

7. Install a data sheet on the recorder platen with the lower edge against the bottom of the recorder, and the left-hand edge against the retaining screw.

8. Set the recorder control switches to POWER ON, PEN UP, and CHART HOLD.

9. Be sure the filter tuning dial is turned to "50".

10. Set up the Recorder ZERO controls for FREQUENCY (X) and AMPLITUDE (Y) until the recorder pen, when in the PEN DOWN position, marks the data sheet at the 500 CPM and Zero amplitude points.

11. Set the 350 instrument filter dial to "500".

12. Set up the X-Y Recorder FULL SCALE control for FREQUENCY (X) so the recorder pen, in PEN DOWN position, marks the data sheet at 5000 CPM frequency and Zero (0) amplitude.

NOTE: The ZERO and FULL SCALE controls interact with one another. Therefore, Steps 9 through 12 must be repeated until the data sheet readings correspond with the 350 tuning dial readings.

13. Set the 350 Analyzer Amplitude Range selector to "TEST". Then, the Amplitude meter should read approximately 0.9 full scale.

14. Set up the X-Y Recorder FULL SCALE control for AMPLITUDE (Y) so the recorder pen, in DOWN position, marks the data sheet at the same amplitude as the Amplitude meter.

15. Set the 350 Analyzer Amplitude Range selector back to "100". The Amplitude meter and the recorder pen should both drop to zero amplitude.

16. Set up the X-Y Recorder ZERO control for AMPLITUDE (Y) so the recorder pen, in PEN DOWN position, marks the data sheet at zero amplitude.

NOTE: The ZERO and FULL SCALE controls interact with one another. Therefore, Steps 13 through 16 must be repeated until the data sheet readings correspond with the 350 Amplitude meter readings.

17. Set the recorder control switches to POWER-STANDBY, PEN UP, and CHART HOLD.

18. Reconnect the vibration transducer, disconnected in Step 1, to the 350 instrument. Then with the Filter-Osc selector set at "OUT", set up the Amplitude Range selector to obtain an "on scale" Amplitude meter reading in either Velocity or Displacement, as desired.

19. Set up the 350 Analyzer controls as follows: Amplitude Range selector to the value selected in Step 18, Filter-Osc selector to "Sharp", Pickup switch to "1" or "2", depending on the channel to be used, Frequency Range selector to "500-5K", Power selector to "AC", and set the tuning dial to "50".

NOTE: When frequencies below 500 CPM are to be plotted, set the Frequency Range selector to "50-500" and change the data sheet frequencies from 500 to 500,000 CPM to 50 to 50,000 CPM.

20. Set the X-Y Recorder control switches to POWER ON, PEN DOWN, and CHART HOLD.

21. Turn the 350 Analyzer tuning dial slowly in a clockwise direction from "50" to "500".

NOTE: If the tuning dial is turned too fast in Step 21, the X-Y Recorder will not produce an accurate vibration signature; errors in both amplitude and frequency will occur.

22. When the tuning dial reaches "500", switch the recorder to PEN UP and set the tuning dial back to "50". Then set the Frequency Range selector to "5K - 50K", or "500-5K" if the analysis started at 50-500 CPM, and set up the X-Y Recorder ZERO control for FREQUENCY (X) until the recorder pen (in DOWN position) marks the data sheet at 5000 CPM (or at 500 CPM if the analysis started at 40-500 CPM).

23. Set the X-Y Recorder to PEN DOWN, and turn the 350 Analyzer tuning dial slowly in a clockwise direction from "50 to 500".

24. Repeat Steps 22 and 23 for the next higher frequency range - 50K-500K (or 5K-50K when the analysis started at 50-500 CPM).

25. Set the X-Y Recorder controls to POWER ON, PEN UP, and CHART-RELEASE. Remove the completed data sheet from the recorder platen.

CAUTION

The X-Y Recorder manual should be reviewed to insure proper operation of the recorder.

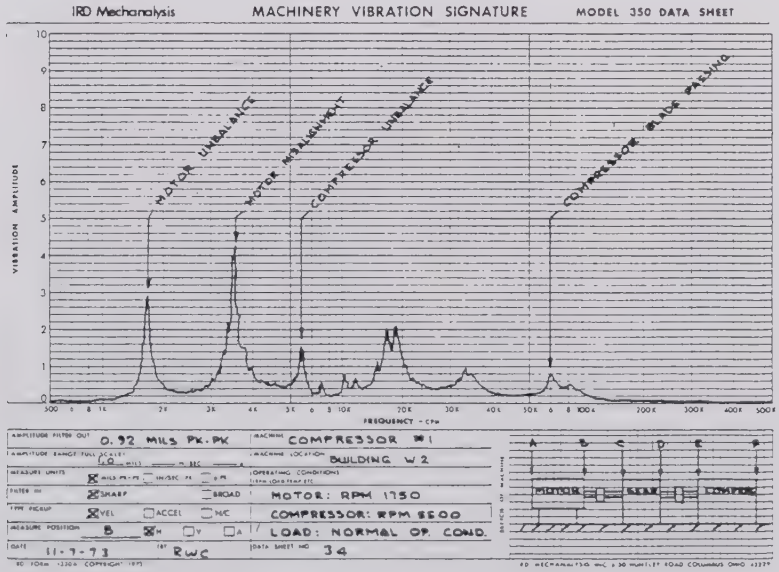


Figure 14C Typical Vibration Signature

RECHARGING BATTEIRES

The Model 350 batteries are high quality Nickel-Cadmium batteries capable of hundreds of charge/discharge cycles in normal instrument operation. To obtain best performance and longest battery life, the batteries should be maintained in a fully charged condition. This is easily done by recharging (1) Whenever the instrument has been used in Battery mode, and (2) once/ month even if the instrument is not in use (Nickel-Cadmium cells lose their charge over a period of several weeks).

To fully charge the Model 350 battery pack:

1. Connect the power cable and plug into an AC power source.
2. Set the POWER selector to "CHARGE".
3. Charge for 16-18 hours (longer periods on CHARGE will not damage the batteries).

When the analyzer is operated with POWER SELECTOR in "AC" a trickle charge will maintain a full charge; however the trickle charge is not adequate for recharging if the batteries are known to be discharged.

BATTERY REPLACEMENT

Normally the rechargeable instrument and strob batteries will not require replacement. However, should it become necessary to replace batteries, use either of the following procedures, as appropriate.

STROBE BATTERY REPLACEMENT (3.6 volt; Part No. 7894)

1. Disconnect the power cable; set the POWER switch to "OFF". Remove the 6 screws marked "A" in Figure 15.

2. Slide the instrument out of the lower case section.

3. Remove the internal fuse shown in Figure 16.

4. Remove the 6 screws marked "B" in Figure 16 and remove the battery pack from the instrument.

   NOTE: Do not disconnect the wires interconnecting the battery pack to the instrument. Avoid excess strain on these wires when the battery pack is removed.

5. Remove the 4 screws marked "C" in Figure 17, and remove the converter housing from the battery mounting plate.

6. Unsolder the battery lead from terminal F (Figure 18); tape the end of the lead, and write down the wire color and the terminal letter (F). Unsolder the lead from terminal G; tape the end of the lead and record the wire color and terminal letter.

7. Remove the four screws marked "D" in Figure 18 which hold the converter circuit board to the converter housing.

8. Remove the battery clamp screw marked "E" in Figure 18.

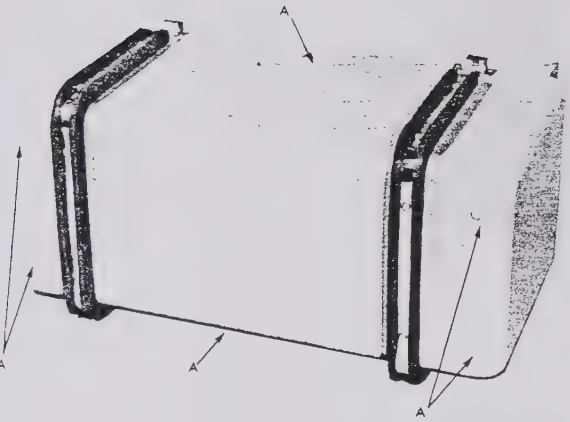


Figure 15

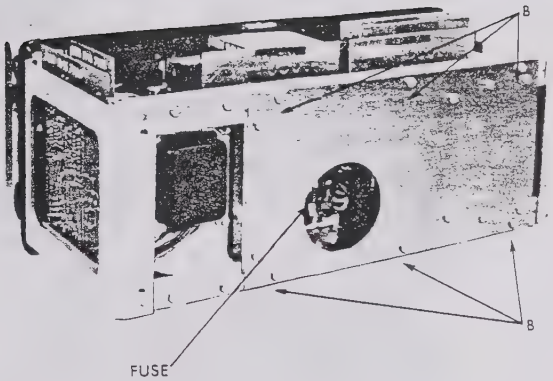


Figure 16

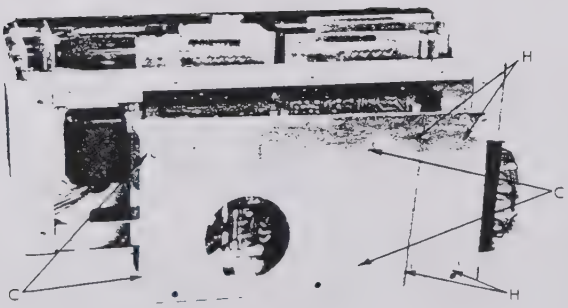


Figure 17

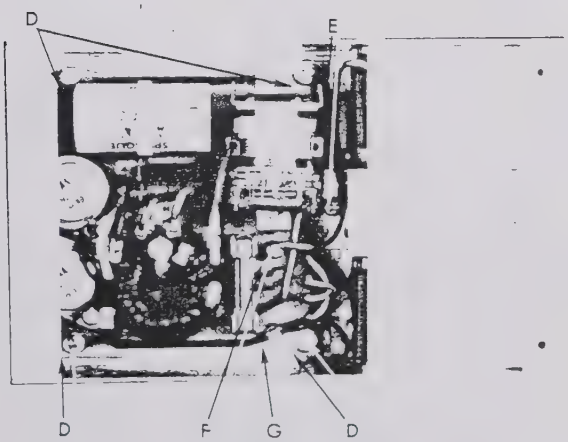


Figure 18

9. Raise the converter PC board to provide clearance to remove the strob battery pack and battery clamp. See Figure 19. Lift the strob battery pack from the converter housing.

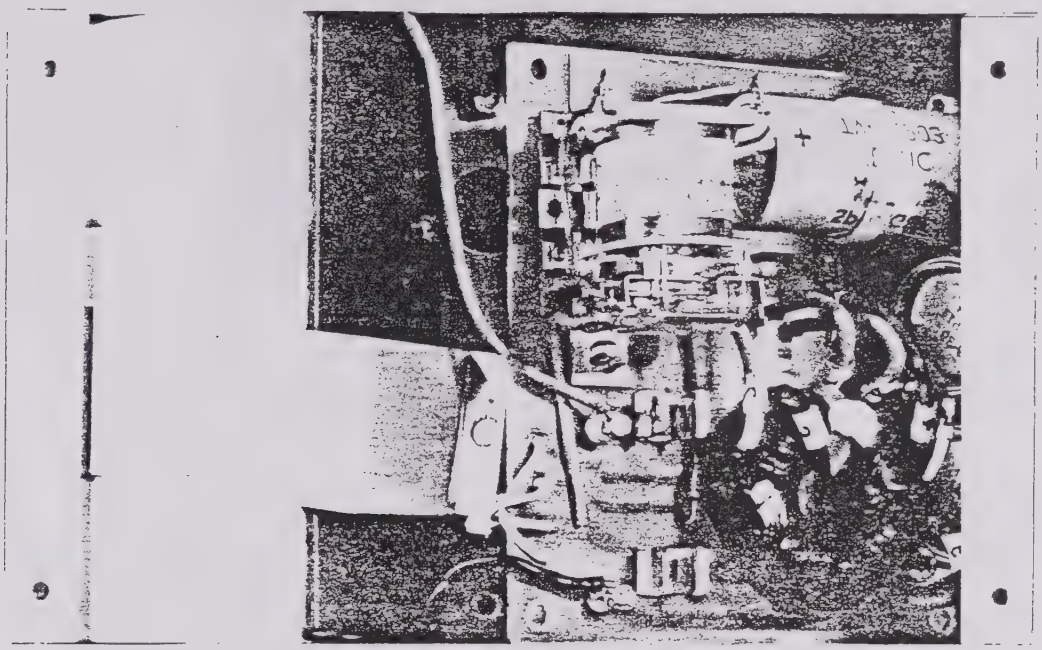


Figure 19

10. Install the replacement strob battery with battery clamp, and lower both the battery and converter PC board into place. See Figure 18; secure the battery in place with the battery clamp screw "E", and secure the converter PC board in place with the 4 screws marked "D".

    CAUTION: Use care in Step 11 to avoid shorting battery leads.

11. Solder the new battery wires to terminals "F" and "G", Figure 18, observing color coding noted in Step 6.

12. Secure the converter housing to the battery mounting plate with the 4 screws marked "C", Figure 17.

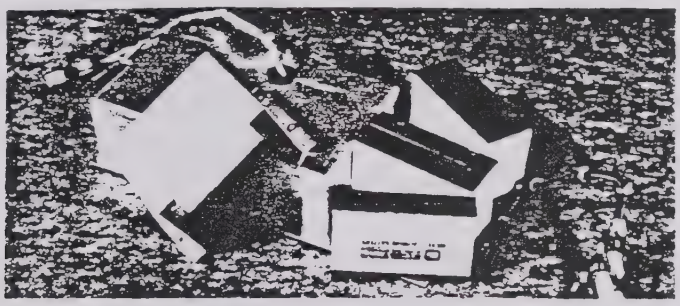
13. Secure the assembled battery pack to the instrument chassis with the 6 screws marked "B", Figure 16. Take care to avoid pinching the interconnecting cables.

14. Install the fuse removed in Step 3.

15. Slide the assembled instrument back into the lower case section and secure with the 6 screws marked "A", Figure 15.

INSTRUMENT BATTERY REPLACEMENT

The instrument battery pack consists of three individual batteries, mounted on the battery mounting plate - see Figure 20.



+12 Volt Battery (Part No. 7896)
-12 Volt Battery (Part No. 7896)
+6 Volt Battery (Part No. 7895)

Figure 20 Instrument Batteries

Replace the instrument batteries as follows:

1. Set the POWER switch to "OFF". Remove the six screws marked "A" in Figure 15.

2. Slide the instrument out of the case.

3. Position the instrument with the terminal strip facing as shown in Figure 21.

4. Disconnect the instrument battery wires at the terminal strip, identified as follows:

TERMINAL	LEAD	BATTERY
19	+12V	+12 Volt
23	GRD	
20	-12V	-12 Volt
24	GRD	
21	+6V	+6 Volt
22	GRD	

NOTE: Remove the battery connections one at a time, and tape the connecting lug to avoid shorting the battery. If only one or two of the 3 instrument batteries are to be removed, disconnect only the required leads.

5. Cut the battery lead cable ties, to free the leads of the batteries being removed.

6. Pull the taped battery leads through the chassis cutout.

7. See Figure 16, position the instrument as shown and remove the 6 screws marked "B". Remove the battery pack from the instrument and lay aside, taking care to avoid strain on the wiring still connected to the chassis.

8. Remove the instrument battery hold-down bracket by removing the 4 screws marked "H" in Figure 17.

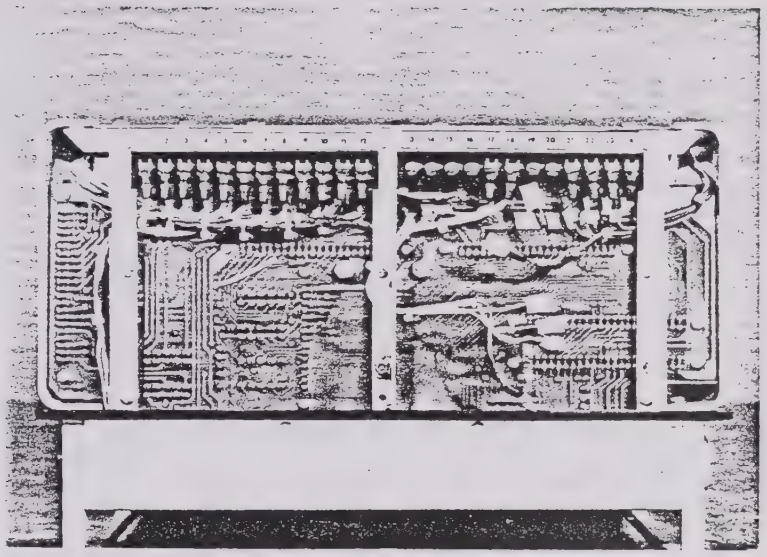


Figure 21 Main Terminal Board

9. Remove the instrument battery to be replaced (+12, -12 or +6 volt), and insert the replacement battery.

10. Replace the battery hold-down bracket removed in Step 8 and secure with the 4 screws marked "H", Figure 17.

11. Replacement battery leads will be longer than necessary; measure the length of the leads on the old battery and cut the new battery leads to the same length.

12. Prepare the ends of the new battery leads with terminal connectors and number tags in the manner shown in Figure 21. To prevent possible damage to the battery from shorting, prepare one lead completely and tape its end before preparing the next lead.

13. Route the battery wires through the cutout provided in the left-rear of the chassis and reconnect to the terminal strip, as indicated in Step 4.

14. Gather all the battery wires and retie with cable ties.

15. Secure the assembled battery pack to the instrument chassis with the 6 screws marked "B", Figure 16. Take care to avoid pinching the interconnecting cables.

16. Slide the assembled instrument back into the lower case section and secure with the 6 screws marked "A", Figure 15.

STROB LAMP REPLACEMENT

To replace the lamp in the Model 569 strob light, proceed as follows:

1. If strob is connected to analyzer, turn POWER switch "OFF", and disconnect strob cable at strob.

2. Remove the 2 side screws which hold the bezel and lens on the strob assembly.

3. Remove bezel, lens and reflector assembly; then remove lamp.

4. Insert replacement lamp (Mechanalysis Part No. 8461), be sure lamp is fully inserted into receptacle.

5. Reinstall the bezel, lens and reflector assembly, and secure with the two side screws.

6. Connect strob cable to strob and analyzer.

7. Slightly loosen the screws in the two rubber feet at the bottom rear of the strob light housing. (Do not loosen bottom forward screw.)

8. Connect analyzer to AC power source and set POWER switch to "AC".

9. Set DISP-VEL selector to "DISP", AMPLITUDE RANGE selector to "TEST", and FILTER-OSC selector to "OUT".

10. Set the strob light toggle switch to the rear "ON" position. Place the front of the strob 4 feet from a flat wall, with the light aimed at the wall. Grasp the cable connector at the rear of the strob with one hand, and hold the strob assembly firmly with the other hand. Push or pull on the connector, to move the internal assembly forward or backward, until the most concentrated light spot is obtained on the wall. When best focus is obtained, turn off strob light and retighten the screws in the 2 rubber feet.

11. Turn POWER switch to "OFF".

OPERATING VOLTAGE CHANGEOVER

The analyzer can be changed over from 117-volt operation to 234-volt operation, or vice-versa, by changing internal jumper connections and fusing as follows:

1. Disconnect power cord; turn POWER switch to "OFF".

2. Remove the 6 screws marked "A" in Figure 15, and slide the instrument out of the case.

3. Position the instrument as shown in Figure 21. Perform Step 4 or 5, as applicable.

4. To change from 117-volt to 234-volt operation:

   a. Without removing other wiring on terminals noted, remove the jumper from terminals 9 and 11, and from terminals 10 and 12. Retighten terminal screws 9 and 12.

   b. Install one of the jumpers on terminals 10 and 11, and tighten the terminal screws. (The other jumper is not used, and can be saved for possible return to 117-volt operation.)

   c. Remove the existing 1/2-ampere fuse from the FUSE holder, and replace with type 3AG 1/4-ampere Slo-Blo (Mechanalysis Part No. 5276). (The 1/2-ampere fuse may be saved for possible return to 117-volt operation.) Refer to Step 6.

5. To change from 234-volt to 117-volt operation:

   a. Locate the jumper connected to terminals 10 and 11. Without removing other wiring, remove the end of the jumper connected to terminal 10, and reconnect this end to terminal 9.

   b. Obtain or make up a jumper similar to the one now connected to

terminals 9 and 11; connect this jumper to terminals 10 and 12. Tighten terminal screws 9 through 12.

c. Remove the existing 1/4-ampere fuse from the FUSE holder, and replace with type 3AG 1/2-ampere Slo-Blo (Mechanalysis Part No. 1511). (The 1/4-ampere fuse should be saved for possible return to 234-volt operation.

6. Change the power-source connector on the power cord to the type required for the new operating voltage.

7. Install instrument in case, using the 6 screws removed in Step 2.

Calibration Procedures

.IP'ATION PROCEDURES

A. :MPT TO CALIBRATE THIS UNIT SHOULD BE MADE EXCEPT BY AN EXPERIENC- QUALIFIED TECHNICIAN, USING THE PROPER TEST EQUIPMENT. IRD MECHANALY- INC. ASSUMES NO RESPONSIBILITY FOR THE OPERATION OF UNITS REPAIRED OR .IBRATED OUTSIDE THE FACTORY OR AUTHORIZED SERVICE DEPOT.

: following test equipment (or equivalent) is required:

1. AC Voltmeter (Hewlett–Packard 403A)
2. Signal Generator (Hewlett–Packard 202C)
3. DC Voltmeter (Hickock DMS 300 with DP100 plug–in unit)

bration of the Model 350 requires access to various internal adjustment controls, which is ıined by removing the instrument from the lower case section as follows:

1. Set the POWER selector to "OFF". Remove the 6 screws marked "A" in Figure 15.
2. Slide the instrument out of the lower case section.

JTION: High voltages are present on exposed terminals of instrument–use care during all bration procedures.

:TER ZERO ADJUSTMENT

the POWER selector "OFF" and the meters in a vertical plane, carefully adjust the meter ro" screws if necessary.

.I.. ADJUSTMENT

GAIN ADJUSTMENT of the instrument involves applying an AC signal from a signal gen- ɔr to the instrument to simulate the Model 544 pickup and adjusting the internal gain con- for the proper reading on the amplitude meter. Proceed as follows:

1. Connect analyzer to AC power source. Set POWER switch to "AC" and allow 20 minutes warmup.
2. Place the AMPLITUDE RANGE selector to "1" (30 on metric model)
3. Switch the FILTER–OSC selector to "OUT".
4. Switch the PICKUP selector to "1".
5. Connect the signal generator output to the VIBRATION PICKUP #1 receptacle on the left side and connect the AC VM. See Figure 22.
6. Adjust the signal generator frequency to 100 Hz.
7. Adjust the signal output amplitude (as read on AC VM) to the pickup sensitivity.

PICKUP SENSITIVITY

On 544 Pickups with serial number prefix "C" or later, the last three figures will be the millivolt level used for calibration of both Displacement and Velocity at 100 cps. On 544 Pickups, which have a calibration

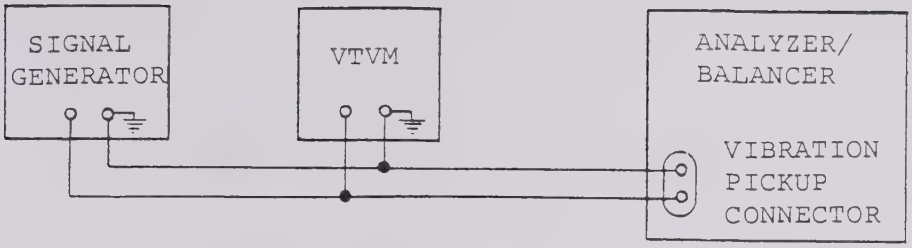


Figure 22 Calibration Setup

sensitivity label applied, the noted sensitivity will be the millivolt level used for calibration of both Displacement and Velocity at 100cps. On pickups that do not have the sensitivity noted, the sensitivity can be obtained by contacting IRD MECHANALYSIS, INC., Columbus, Ohio. State Pickup serial number and Model number, or if extreme accuracy is not needed, 240* mv can be used. This figure represents the Model 544 output at 100 Hz at a 1 mil shake (.314 in/sec at 100 Hz) ±10%.
(*284 mv on metric model)

8. Place the DISP-VEL selector to "DISP", and adjust P131, Figure 23, for a full scale (1 mil) reading. (30 micron reading on metric model)

9. Place the DISP-VEL selector to "VEL".

10. Place the AMPLITUDE RANGE selector to ".3" ("10" mm/sec on metric model) and adjust P101 for a full-scale reading of "1" on the 0-to-1 scale of the AMPLITUDE meter ("3" on the 0 to 3 scale on metric model).

    NOTE: The remaining steps calibrate the amplitude and frequency of the oscillator signal utilized for the "TEST" function of the Model 350.

11. Place the AMPLITUDE RANGE selector to "TEST", DISP-VEL selector to "DISP", and FREQ RANGE to "500-5K".

12. Adjust P162 to obtain an AMPLITUDE meter reading of 0.9.

13. Adjust P161 to obtain a FREQUENCY meter reading of 400.

14. Reseal adjustment screws of P101, P131, P161 and P162 with Glyptal varnish or equivalent.

TILTER CALIBRATION

Preliminary Setup

1. Connect the power cable to AC power, and place the POWER switch to "AC", then allow 20 minutes warmup.

2. Set the DISP-VEL selector to "VEL".

3. Set the AMPLITUDE RANGE selector to "1.0". ("10" on metric model)

4. Set the PICKUP selector to "1".

5. Connect the signal generator output to Vibration Pickup No. 1 receptacle at left-hand side of 350 panel (see Fig. 22). The AC VM is not used in this Step.

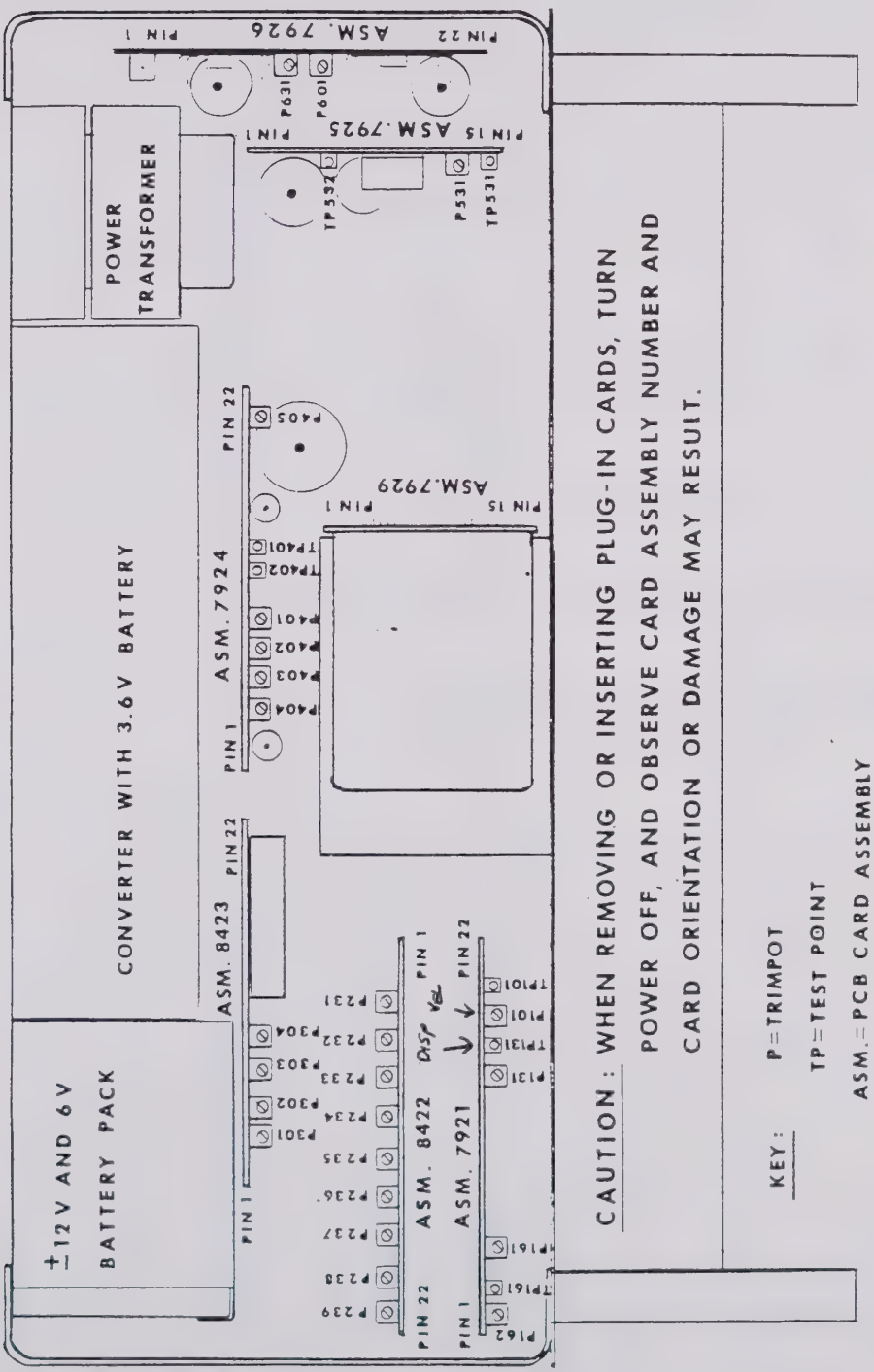


Figure 23 Adjustment Potentiometer Locations

50K to 500K FILTER RANGE ADJUSTMENT

1. Set the FREQ RANGE selector to "50K–500K".
2. Set the FILTER–OSC selector to "OUT".
3. Set the signal generator frequency to 1000 Hz, and adjust the output amplitude of the signal generator to obtain an AMPLITUDE meter reading of 0.9.
4. Set the FILTER–OSC selector to "SHARP".
5. Slowly and carefully adjust the filter tuning control for a peak (maximum) AMPLITUDE meter indication.
6. Adjust the "SHARP/50K–500K" meter amplifier gain pot P239 for an AMPLITUDE meter reading of 0.9.
7. Set the FILTER–OSC selector to "OUT".
8. Set the signal generator frequency to 8.00 KHz, and adjust the output amplitude of the signal generator for an AMPLITUDE meter reading of 0.9.
9. Set the FILTER–OSC selector to "SHARP".
10. Slowly and carefully adjust the filter tuning control for a peak AMPLITUDE meter indication.
11. Adjust the "50K–500K" filter trim pot P304 for exactly a 0.9 AMPLITUDE meter indication. While making this adjustment, readjust the filter tuning control to maintain a peak reading.
12. Repeat steps 2 through 11 above until a 0.9 amplitude meter reading is obtained at both frequencies (1000 Hz and 8.00 KHz) without further adjustment.
13. Set the FILTER–OSC selector to "OUT".
14. Set the signal generator frequency to 1000 Hz, and adjust the output amplitude of the signal generator for a 0.9 AMPLITUDE meter indication.
15. Set the FILTER–OSC selector to "BROAD".
16. Slowly and carefully adjust the filter tuning control for a peak AMPLITUDE meter reading.
17. Adjust the "BROAD/50K–500K" meter amplifier gain pot P235 for a 0.9 AMPLITUDE meter indication.
18. Set the FILTER–OSC selector to "OUT".
19. Set the signal generator frequency to 8.00 KHz, and adjust the output amplitude of the signal generator for a 0.9 AMPLITUDE meter reading.
20. Set the FILTER–OSC selector to "BROAD".
21. Slowly and carefully adjust the filter tuning control for the peak AMPLITUDE meter indication. The peak amplitude meter indication should be 0.9, ±10% of full scale.

To complete the filter calibration, repeat the procedure on Page 44 for the 50K-500K range, for the 5K to 50K, 500 to 5K and 50 to 500 CPM ranges. Table 1 below outlines the frequency range, the upper and lower frequency limits and associated adjustment potentiometers for this calibration procedure. Reseal all adjustment potentiometers with Glyptal varnish or equivalent.

Table 1

FREQUENCY RANGE (CPM)	50–500	500–5K	5K–50K	50K–500K
LOW FREQUENCY CALIBRATION POINT	1 Hz (60 CPM)	10 Hz (600 CPM)	100 Hz (6000 CPM)	1000 Hz (60,000 CPM)
HIGH FREQUENCY CALIBRATION POINT	8 Hz (480 CPM)	80 Hz (4800 CPM)	800 Hz (48,000 CPM)	8000 Hz (480,000 CPM)
"SHARP" METER AMPLI FIER GAIN POT LOW FREQUENCY ADJ	P236	P237	P238	P239
TRIM POT HIGH FREQUENCY ADJ	P301	P302	P303	P304
"BROAD" METER AMPLIFIER GAIN POT LOW FREQUENCY ADJ	P232	P233	P234	P235

FREQUENCY METER CALIBRATION

1. Connect the power cable to AC power, set the POWER switch to AC, then allow 20 minutes warmup.
2. Set the AMPLITUDE RANGE selector to "1" ("10" on metric model).
3. Set the DISP-VEL selector to "VEL".
4. Set the FILTER-OSC selector to "OUT".
5. Set the PICKUP selector to "1".
6. Connect the signal generator output to the VIBRATION PICKUP #1 receptacle on the left hand side panel of the 350 as shown in Figure 22. The AC VM is not needed in this Step.
7. Set the signal generator frequency to 100 Hz (6,000 CPM) and adjust the output amplitude of the signal generator for a 0.9 AMPLITUDE meter indication.
8. Set the FREQ RANGE selector to "500-5K".
9. Set the Frequency Meter Full-Scale Pot, P405, so the 350 FREQUENCY meter reads one minor scale division above 500; do not allow meter pointer to "peg".
10. Set the signal generator frequency to 8 Hz (480 CPM), and adjust the output amplitude for a 0.9 AMPLITUDE meter indication.

11. Set the FREQ RANGE selector to "50-500".

12. Set P401 so the FREQUENCY meter reads exactly 480 CPM.

13. Repeat Steps 10 through 12 for the 500-5K, 5K-50K and 50K-500K frequency ranges, using the correct adjustment potentiometer and signal generator frequencies listed in Table 2. Signal generator output amplitude should always be adjusted for an AMPLITUDE meter indication of 0.9. Reseal all adjustments potentiometers with Glyptal varnish.

Table 2

FREQUENCY RANGE	50–500	500–5K	5K–50K	50K–500K
FREQUENCY CALIBRATION POT	P401	P402	P403	P404
SIGNAL GENERATOR FREQUENCY	8 Hz (480 CPM)	80 Hz	800 Hz	8000 Hz
FREQUENCY METER	480 CPM	4800 CPM	48,000 CPM	480,000 CPM

FILTER DIAL ADJUSTMENT

1. Connect the power cable to AC power, place the POWER selector to "AC", then allow 20 minutes warmup.

2. Set the AMPLITUDE RANGE selector to "1" ("10" on metric model)

3. Set the DISP-VEL selector to "VEL".

4. Set the FILTER-OSC selector to "OUT".

5. Set the PICKUP selector to "1".

6. Connect signal generator output to VIBRATION PICKUP No. 1 receptacle at left-hand side panel of 350, as shown in Figure 22. The ACVM is not used in this step.

7. Set the signal generator frequency to 50 Hz (3000 CPM), and adjust the output amplitude for a 0.9 AMPLITUDE meter indication.

8. Set the FREQ-RANGE selector to "500-5K".

9. Set the FILTER-OSC selector to "SHARP".

10. Slowly and carefully adjust the filter tuning control to obtain a peak AMPLITUDE meter reading.

11. Loosen the filter tuning dial if necessary and set the dial to rea exactly 3000 CPM. See Figure 24.

12. Retighten the tuning dial. Be sure the peak amplitude reading occurs when the filter tuning dial reads 3000 CPM.

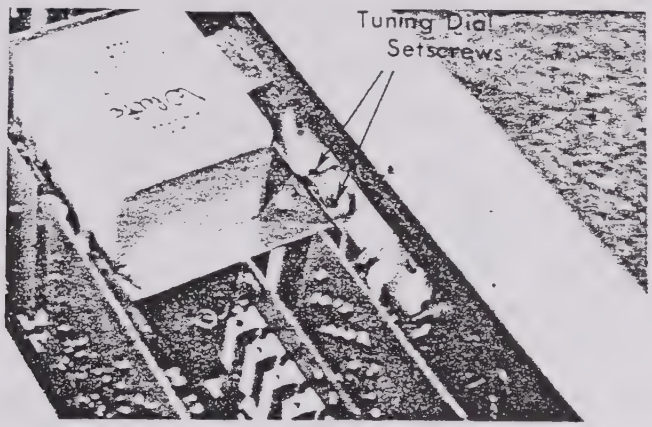


Figure 24

POWER SUPPLY VOLTAGE ADJUSTMENT

CAUTION: High voltage exists in the instrument. Always turn the POWER switch "OFF" and wait a few minutes for the high voltage to decay before making any internal connections. Keep clear of terminals 5, 6, and 9 through 12, under the main printed-circuit board at the rear of the instrument.

1. Be sure the batteries are fully charged, using the method described in PREPARATION PROCEDURE.

2. Set POWER selector to "OFF" and connect analyzer to AC power source.

3. Connect positive lead of DC voltmeter to test point TP401; connect negative lead to test point TP402. See Figure 23 for test point locations.

4. Set the POWER selector to "BATTERY" and record the voltmeter reading. (The reading must be between 4.9 and 5.3 volts; this is the voltage across the 5.1-volt Zener diode D602.)

5. Set the POWER selector to "AC".

6. Set P531 so voltmeter reads same value recorded in Step 4.

7. Set the POWER selector to "OFF".

8. Connect the positive lead of the voltmeter to terminal 19 of the barrier terminal strip at bottom side of main PC board; connect the negative lead to TP402.

9. Set the POWER selector to "AC".

10. Set P601 so voltmeter reads 13.5 volts.

11. Set the POWER selector to "OFF".

12. Connect the negative lead of the voltmeter to terminal 20 of the barrier terminal strip at bottom side of main PC board; connect the positive lead to TP402.

13. Set POWER selector to "AC".

14. Set P631 so voltmeter reads 13.5 volts.

15. Set POWER selector to "OFF", then disconnect voltmeter.

16. Reseal adjustment controls P531, P601, and P631 with glyptal, varnish, or equivalent.

SPECIFICATIONS FOR MODEL 1080 X-Y RECORDER

Chart Size:	8-1/2 x 11 inches.
Chart Holddown:	Electrostatic.
Pens:	Felt Tip Cartridges.
Pen Lift:	Electric.
Input Resistance:	1.0 meg-ohm
Zero Set (X and Y): . . .	Zero adjustable to one full-scale in any direction.
Slewing Speed:	20 inches/second.
Dimensions, Case:	19-3/4 x 14-1/2 x 7 in. (50.2 x 36.8 x 17.8 cm)
Weight:	29 lbs. (13.2 Kg)
Power:	105-129 v/210-258v @ 50/60 Hz, 45 watts.
Standard Accessories: . .	Signal Cable (1), 5-foot, 3-section, P/N 11866 (BNC connectors at analyzer end).
. .	Pen Cartridges (12), Pkg/3 Red, P/N 11514 Pkg/3 Blue, P/N 11515 Pkg/3 Green, P/N 11516 Pkg/3 Black, P/N 11517
. .	Spare Fuses, One 1/4-Amp, P/N 5276, One 1/8-Amp, P/N 5945
. .	Slidewire Maintenance Kit, Lubricant P/N 11921, Cleaner, P/N 11920.
. .	Power Cable, 5-foot, P/N 11919
. .	Recorder Operator Manual

AUTHORIZED SERVICE DEPOTS

USA

IRD Mechanalysis, Inc.
6150 Huntley Road
Columbus, Ohio 43229
Phone: 614/884-5376
Telex: 24-5318 IRD MECH

IRD Mechanalysis, Inc.
Building C3
6001 Gulf Freeway
Houston, Texas 77023
Phone: 713/921-2145

IRD Mechanalysis, Inc.
Suite 114
3120 Maple Drive
Altanta, Georgia 30305
Phone: 404/237-9427

IRD Mechanalysis, Inc.
Suite A2
221 South Chester Pike
Glenolden, Penna. 19036
Phone: 215/461-7060

IRD Mechanalysis, Inc.
Suite 4
3377 Mt. Diablo Boulevard
Layfayette (San Francisco)
California 94549
Phone: 415/283-2065

IRD Mechanalysis, Inc.
1131 Warren Avenue
Downers Grove, Illinois 60515
Phone: 312/960-4065

CANADA

IRD Mechanalysis Limited
333 Barton Street East
Stoney Creek, (Hamilton)
Ontario, Canada L8E 2L1
Phone: 416/662-7577
Telex: 061-8453

IRD Mechanalysis Limited
Room 301
524 17 Avenue, S. W.
Calgary, Alberta
Canada T2S OB2
Phone: 403/264-4130
Telex: 03-824680

UNITED KINGDOM

IRD Mechanalysis (UK) Limited
Bumpers Lane
Sealand Industrial Estate
Chester, United Kingdom CH1 4LT
Phone: Chester 44/244/374914-5
Chester 44/244/317557-8
Telex: 851-617034 IRD MECH G

WESTERN EUROPE

IRD Mechanalysis, S.A.
Avenue Winston Churchill 98
B1180 Brussels, Belgium
Phone: 32/2/344.70.58
32/2/344.72.18
Telex: 846-61256 IRD BRU B

To order a part not listed in this manual, provide a complete description of the part, and include its function and location.

OBTAINING SERVICE

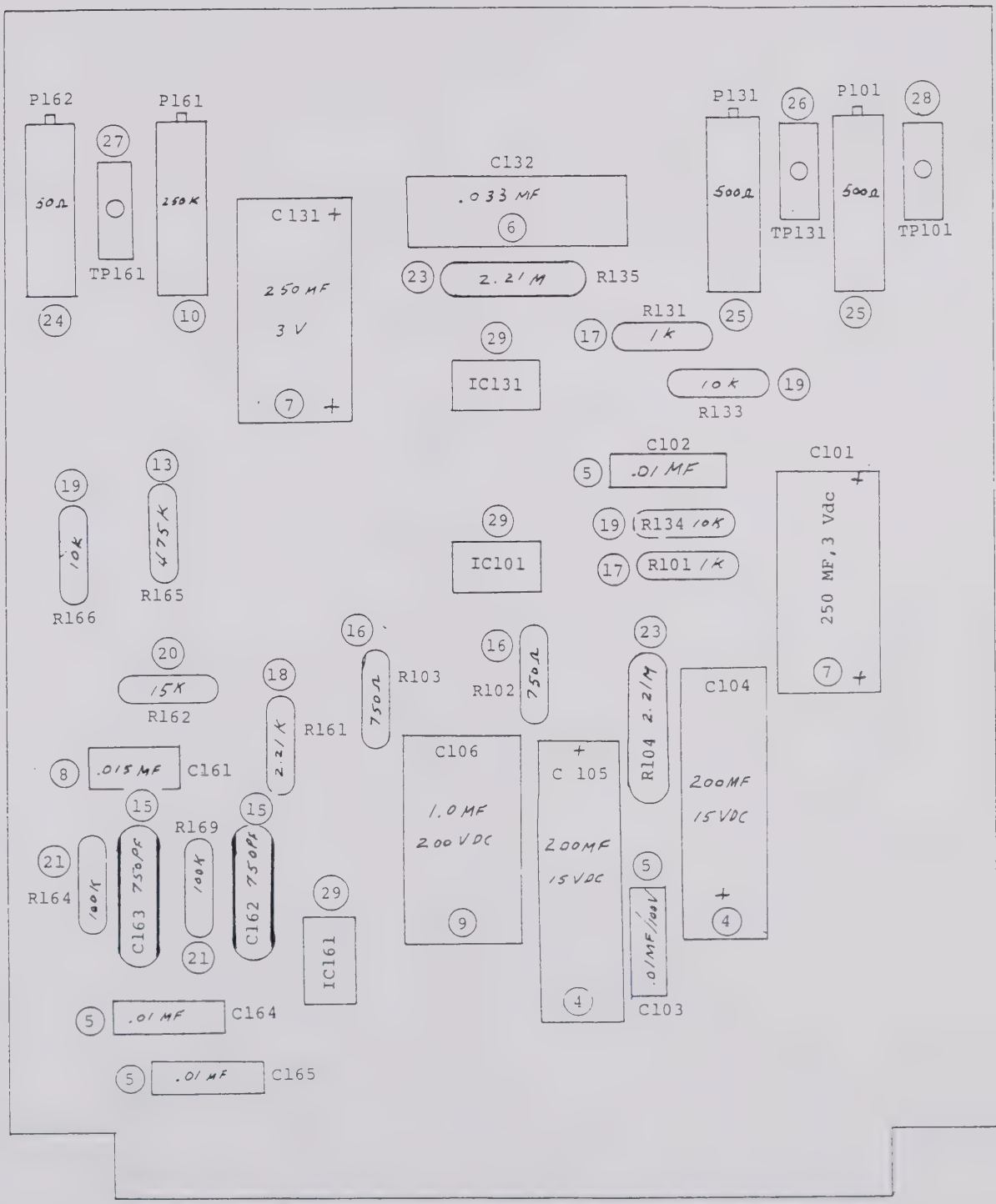
Obtain service or shipping instructions from either your local IRD Mechanalysis Service Depot or the IRD home office (see addresses and phone numbers on Page 49). Package the Model 350 instrument, along with the vibration pickup(s), strob light, power cord, and interconnecting cables carefully inside a strong carton. Package the Model 1080 X-Y Recorder in its padded storage case along with the power cord and signal cable assembly. Then package this storage case inside a strong carton. Be sure each article is well padded.

ADDENDUM A

This ADDENDUM contains illustrations and parts listings of sub-assemblies used in the Model 350, plus a Schematic Block Diagram and Electrical Schematic Drawing of the instrument circuits. Where possible, the illustrations and parts listings are referenced to the Assembly and Electrical Schematic Drawings. The Illustrations, Parts Listings and Electrical Drawings included in this Addendum are as follows:

NAME	PAGE
Buffer Integrator, Board 100, Part No. 7921	A-2
Parts List for Board 100	A-3
Logic As'sy., Board 400, Part No. 7924	A-4
Parts List for Board 400	A-5
High Voltage & 5V P.S., Board 500, Part No. 7925	A-6
Parts List for Board 500	A-7
±12 VDC PS/SCR, Board 600, Part No. 7926	A-8
Parts List for Board 600	A-9
Attenuator, Board 700, Part No. 7927	A-10
Parts List for Board 700	A-11
Converter and Battery Pack, Part No. 7935	A-12
Parts List for Converter	A-13
Converter P.S., Board 1300, Part No. 7928	A-14
Parts List for Board 1300	A-15
Twin T Filter, Board 900, Part No. 7929	A-16
Parts List for Board 900	A-17
Filter Meter Amp., Board 200, Part No. 8422	A-18
Parts List for Board 200	A-19
Limiter Threshold, Board 300, Part No. 8423	A-20
Parts List for Board 300	A-21
Main Board, Part No. 8430	A-22
Parts List for Main Board	A-23
X-Y Plotter, Part No. 10455	A-24
Parts List for X-Y Plotter	A-25
Strob Light Cable, Part Nos. 8720, 8721, or 8723	A-26
Parts List for S.L. Cable	A-27
Schematic Block Diagram, Drawing D6-3560, Sheet 1	A-29
Electrical Schematic, Drawing D6-3560, Sheet 2	A-31

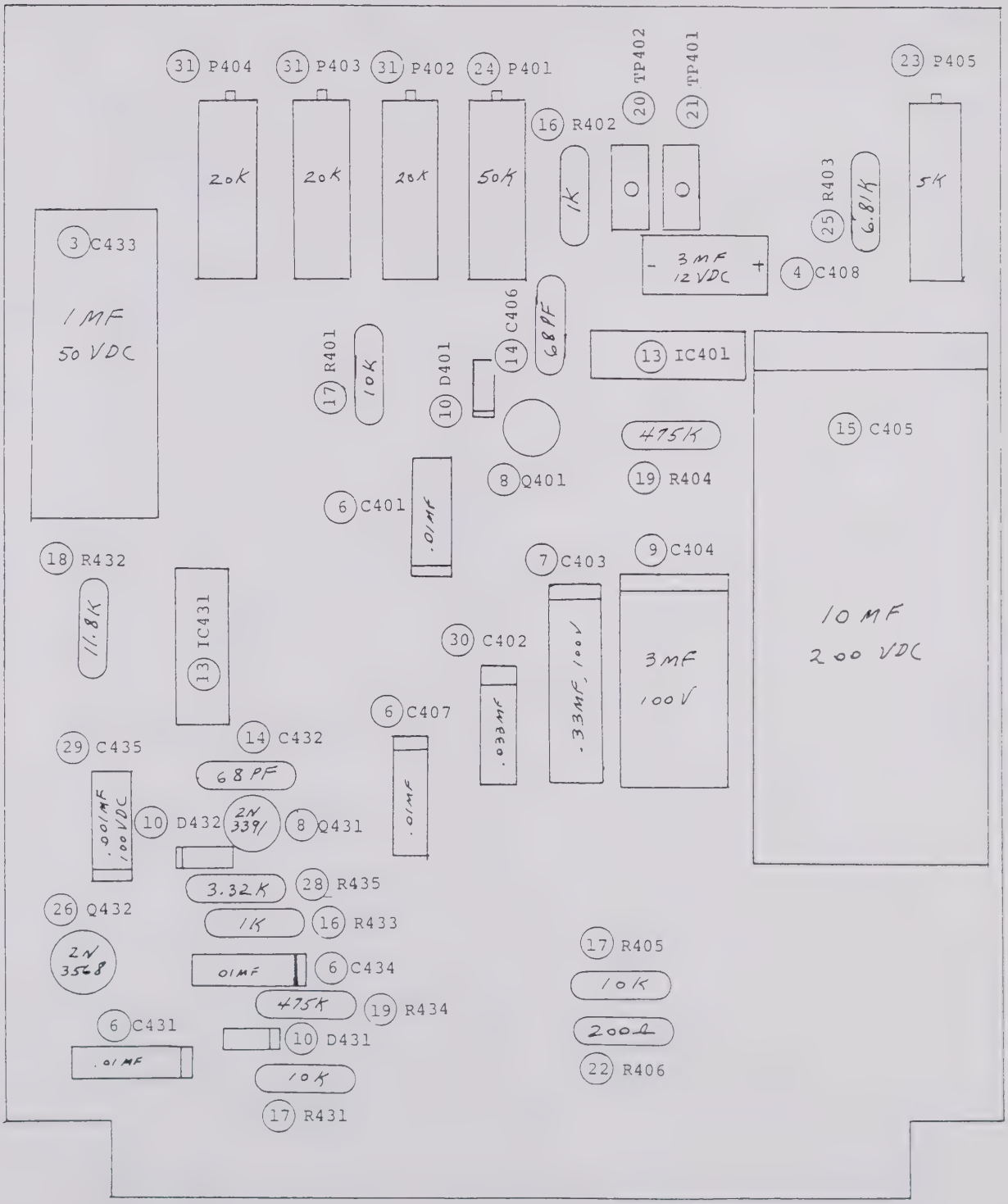
BUFFER INTEGRATOR
PART NO. 7921/C2-3405
Electrical Schematic No. D6-3560, Sheet 2



BUFFER INTEGRATOR
BOARD 100
Part No. 7921/C2-3405
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly	7921
4	Capacitor (C104 & 105), 200 MF, 15Vdc, EL	3533
5	Capacitor (C102, 103, 164 & 165), 0.01 MF, 100 Vdc	4572
6	Capacitor (C132), 0.033 MF, 100 Vdc, 1%	4987
7	Capacitor (C101 & 131), 250 MF, 3 Vdc, not polarized	5023
8	Capacitor (C161), 0.015 MF, 200 Vdc	5041
9	Capacitor (C106), 1.0 MF, 200 Vdc, 10%	5044
10	Potentiometer (P161), 250K ohms, multi-turn	9240
12	Basic PC Board	7701
13	Resistor (R165), 475K ohms, 1/4 W, 1%	7242
15	Capacitor (C162 & 163), 750 PF, 500 Vdc	7838
16	Resistor (R102 & 103), 750 ohms, 1/8 W, 1%	7847
17	Resistor (R101 & 131), 1K ohms, 1/8 W, 1%	7848
18	Resistor (R161), 2.21K ohms, 1/8 W, 1%	7852
19	Resistor (R133, 134 & 166), 10K ohms, 1/8 W, 1%	7859
20	Resistor (R162), 15K ohms, 1/8 W, 1%	7860
21	Resistor (R163 & 164), 100K ohms, 1/8 W, 1%	7868
23	Resistor (R104 & 135), 2.21 Meg ohms, 1/2 W, 1%	7874
24	Potentiometer (P162), 50 ohms, multi-turn	7883
25	Potentiometer (P101 & 131), 500 ohms, multi-turn	7884
26	Test Jack (TP131), Yellow Tip	7887
27	Test Jack (TP161), Gray Tip	7888
28	Test Jack (TP101), White Tip	7889
29	Semiconductor (IC101, 131 & 161), IC L741LCN-PA, Low Noise	9692

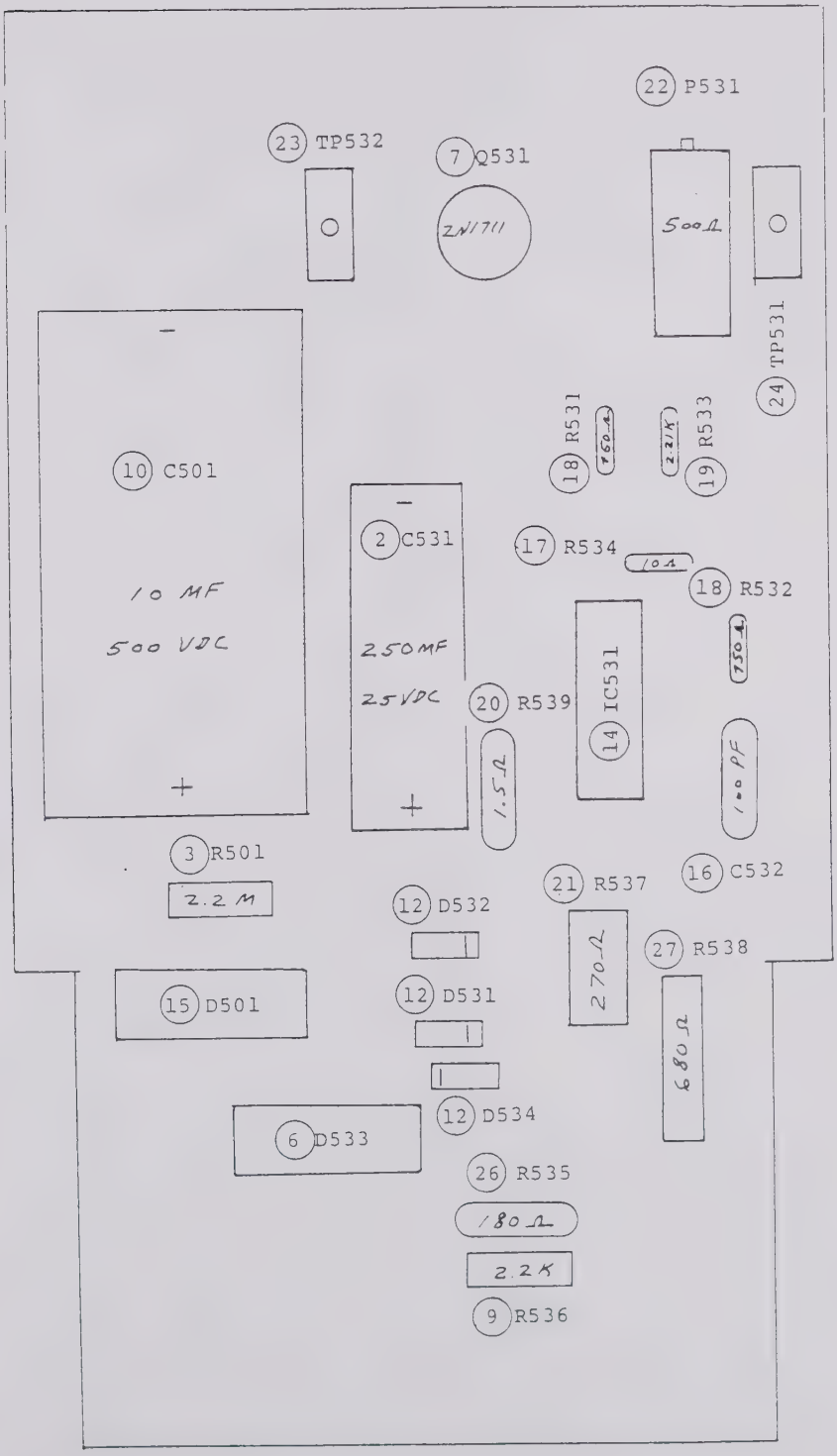
LOGIC PC BOARD
PART NO. 7924/C2-3408
Electrical Schematic, D6-3560, Sh. 2



LOGIC ASSEMBLY, BOARD 400
Part No. 7924/C2-3408
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly	7924
3	Capacitor (C433), 1.0 MF, 50 Vdc, 1%	3501
4	Capacitor (C408), 3.0 MF, 12 Vdc, El.	3530
6	Capacitor (C401, 407, 431 & 434), 0.01 MF, 100 Vdc	4572
7	Capacitor (C403), 0.33 MF, 100 Vdc	5037
8	Semiconductor (Q431, 401), 2N3391	4826
9	Capacitor (C404), 3.0 MF, 100 Vdc	9002
10	Semiconductor (D401, 431, 432), 1N914A, Diode	5398
12	Basic PC Board	7704
13	Semiconductor (IC431, 401), MC8601P, IC	7829
14	Capacitor (C432, 406), 68PF, 500 Vdc	7836
15	Capacitor (C405), 10 MF, 200 Vdc	7839
16	Resistor (R433, 402), 1K ohms, 1/8 W, 1%	7848
17	Resistor (R431, 405, 401), 10K ohms, 1/8 W, 1%	7859
18	Resistor (R432), 11.8K ohms, 1/8 W, 1%	8414
19	Resistor (R434, 404), 475K ohms, 1/8 W, 1%	7871
20	Test Jack (TP402), Black Tip	7885
21	Test Jack (TP401), Red Tip	7886
22	Resistor (R406), 200 ohms, 1/8 W, 1%	8501
23	Potentiometer (P405), 5K ohms, Multi-turn	8337
24	Potentiometer (P401), 50K ohms, Multi-turn	8338
25	Resistor (R403), 6.81K ohms, 1/8 W, 1%	7857
26	Semi-Conductor (Q432), 2N3568	4583
28	Resistor (R435), 3.32K ohms, 1/8 W, 1%	7854
29	Capacitor (C435), 0.001 MF, 100 Vdc	4951
30	Capacitor (C402), 0.033 MF, 100 Vdc	9001
31	Potentiometer (P402, 403 & 404), 20K ohms, Multi-turn	5476

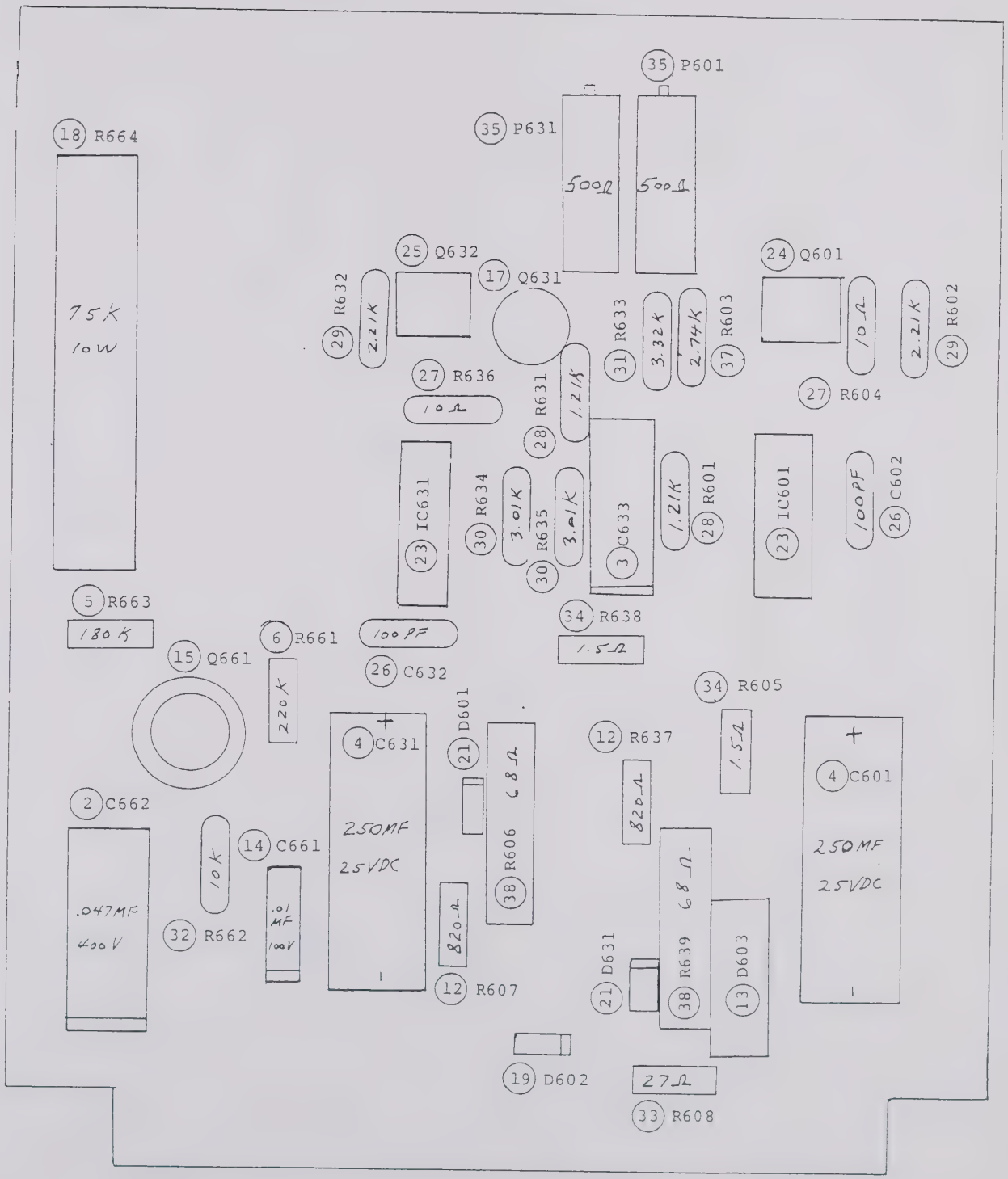
HIGH VOLTAGE AND 5-VOLT POWER SUPPLY
PART NO. 7925/C2-3409
Electrical Schematic, D6-3560, Sh. 2



HIGH VOLTAGE AND 5 VOLT POWER SUPPLY
BOARD 500
Part No. 7925/C2-3409
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly	7925
2	Capacitor (C531), 250 MF, 25 Vdc, El.	1491
3	Resistor (R501), 2.2 Meg ohms, 1/2 W, 5%	1618
6	Semiconductor (D533), FWL 200	3565
7	Semiconductor (Q531), 2N1711	3893
9	Resistor (R536), 2.2K ohms, 1/2 W, 5%	1591
10	Capacitor (C501), 10 MF, 500 Vdc, El.	4686
12	Semiconductor (D532, 531 & 534), 1N4003, Diode	5948
13	Basic PC Board	7705
14	Semiconductor (IC531), UA723	7830
15	Semiconductor (D501), FWL600	7834
16	Capacitor (C532), 100 PF, 500 Vdc	7837
17	Resistor (R534), 10 ohms, 1/8 W, 1%	7840
18	Resistor (R531, 532) 750 ohms, 1/8 W, 1%	7847
19	Resistor (R533), 2.21K ohms, 1/8 W, 1%	7852
20	Resistor (R539), 1/5 ohms, 1-1/2 W, 5%	7879
21	Resistor (R537), 270 ohms, 3-1/4 W, 5%	7881
22	Potentiometer (P531), 500 ohms, Multi-turn	7884
23	Test Jack (TP532), Black Tip	7885
24	Test Jack (TP531), Red Tip	7886
25	Heat Sink (With Q531, item 7)	7939
26	Resistor (R535), 180 ohms, 1-1/2 W, 5%	11681
27	Resistor (R538), 680 ohms, 1W, 5%	5678

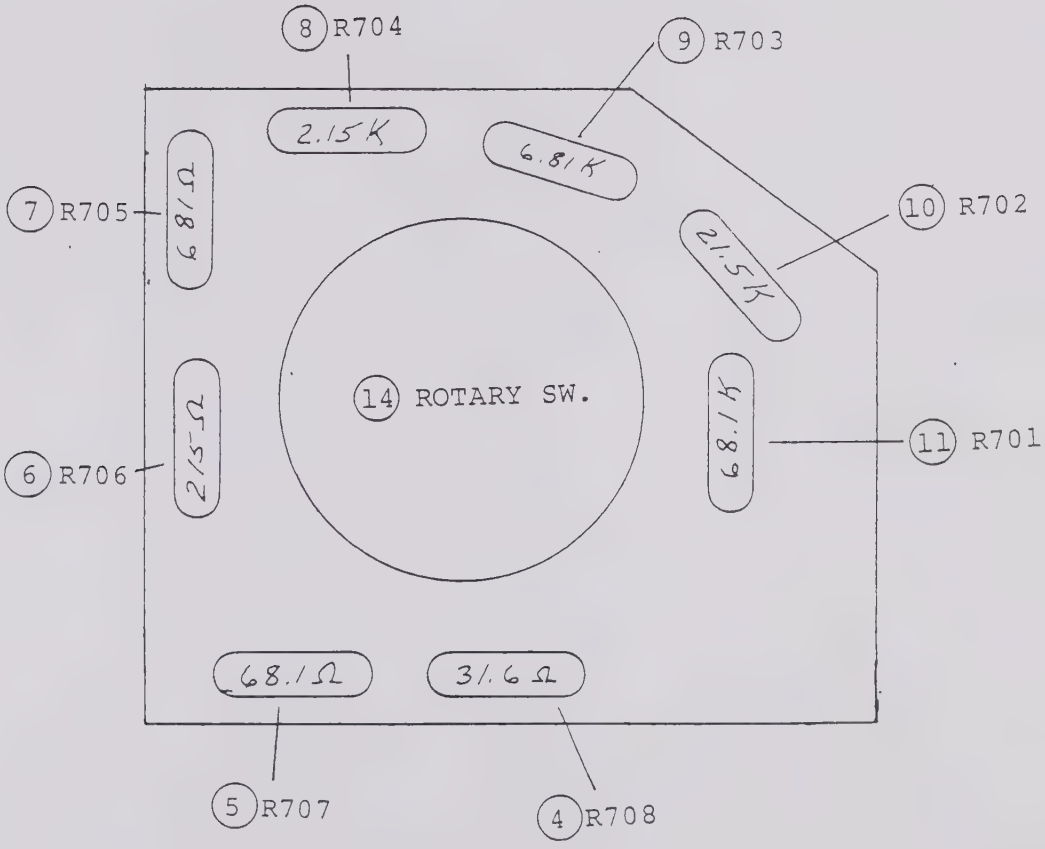
±12 VDC POWER SUPPLY/SCR
PART NO. 7926/C2-3410
Electrical Schematic, D6-3560, Sh. 2



±12 VDC POWER SUPPLY/SCR
BOARD 600
Part No. 7926/C2-3410
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly - (Board No. 600)	7926
2	Capacitor (C662), 0.047 MF, 400 Vdc	1434
3	Capacitor (C633), 0.047 MF, 200 Vdc	1446
4	Capacitor (C631, 601), 250 MF, 25 Vdc, El.	1491
5	Resistor (R663), 180K ohms, 1/2 W, 5%	1608
6	Resistor (R661), 220K ohms, 1/2 W, 5%	1609
12	Resistor (R607, 637), 820 ohms, 1/2 W, 5%	3317
13	Semiconductor (D603), FWL 200	3565
14	Capacitor (C661), 0.01 MF, 100 Vdc	4572
15	Semiconductor (Q661), 2N4187	4587
17	Semiconductor (Q631), 2N3644	5091
18	Resistor (R664), 7500 ohms, 18 W, 10%	5118
19	Semiconductor (D602), 1N5231B, Zener	5399
21	Semiconductor (D601, 631), 1N4003, Diode	5948
22	Basic PC Board	7706
23	Semiconductor (IC601, 631), UA723	7830
24	Semiconductor (Q601), NPN, D40D4	7832
25	Semiconductor (Q632), PNP, D41D4	7833
26	Capacitor (C632, 602), 100 PF, 500 Vdc	7837
27	Resistor (R604, 636), 10 ohms, 1/8 W, 1%	7840
28	Resistor (R601, 631), 1.21K ohms, 1/8 W, 1%	7849
29	Resistor (R602, 632), 2.21K ohms, 1/8 W, 1%	7852
30	Resistor (R634, 635), 3.01K ohms, 1/8 W, 1%	7853
31	Resistor (R633), 3.32K ohms, 1/8 W, 1%	7854
32	Resistor (R662), 10K ohms, 1/8 W, 1%	7859
33	Resistor (R608), 27 ohms, 1/2 W, 5%	7878
34	Resistor (R638, 605), 1.5 ohms, 1-1/2 W, 5%	7879
35	Potentiometer (P601, 631), 500 ohms, Multi-turn	7884
36	Heat Sink (2 Req'd) for Q601 & 632	7902
37	Resistor (R603), 2.74K ohms, 1/8 W, 1%	7947
38	Resistor (R606, 639), 68 ohms, 5 W, 5%	8344

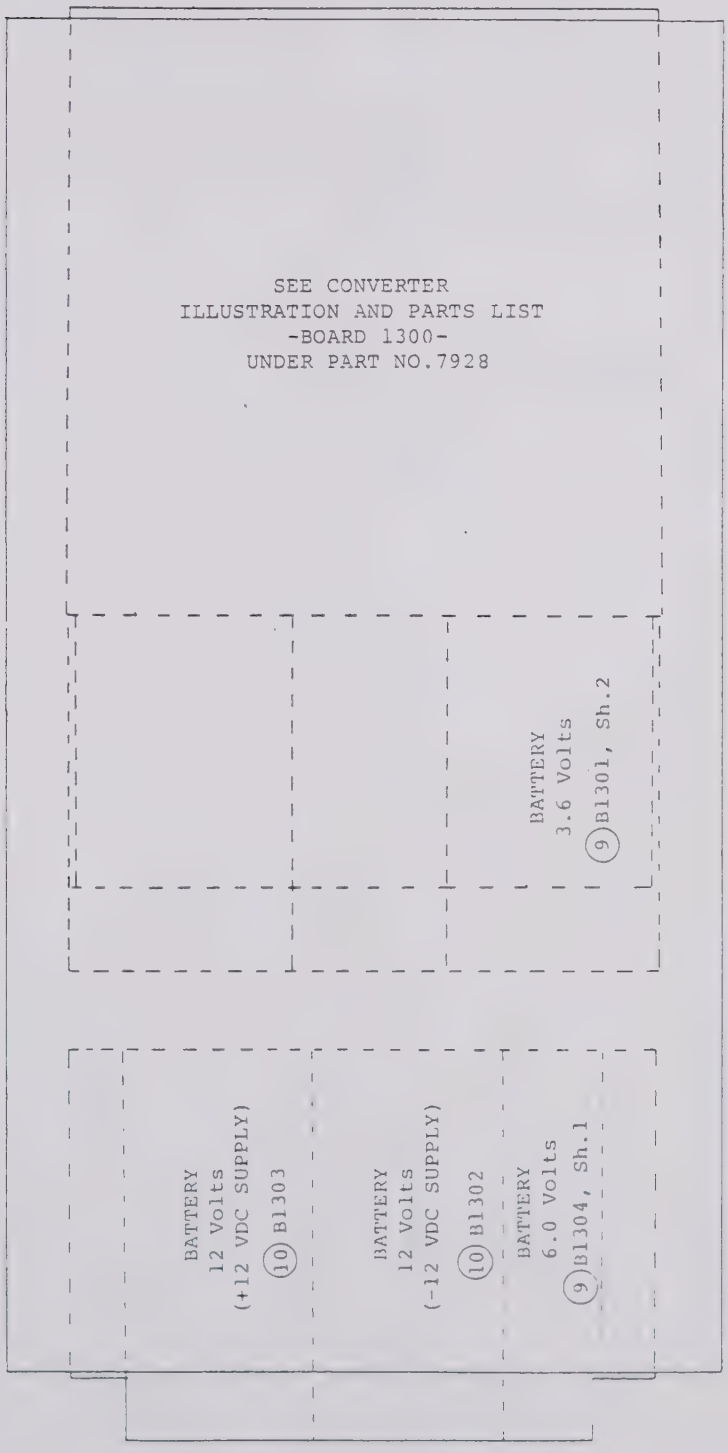
ATTENUATOR PC BOARD
PART NO. 7927/B2-3411
Electrical Schematic, D6-3560



ATTENUATOR
BOARD 700
Part No. 7927/B2-3411
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board, Assembly/B2-3411	7927
3	Basic PC Board	7707
4	Resistor (R708), 31.6 ohms, 1/8 W, 1%	7841
5	Resistor (R707), 68.1 ohms, 1/8 W, 1%	7842
6	Resistor (R706), 215 ohms, 1/8 W, 1%	7844
7	Resistor (R705), 681 ohms, 1/8 W, 1%	7846
8	Resistor (R704), 2.15K ohms, 1/8 W, 1%	7851
9	Resistor (R703), 6.81K ohms, 1/8 W, 1%	7857
10	Resistor (R702), 21.5K ohms, 1/8 W, 1%	7862
11	Resistor (R701), 68.1K ohms, 1/8 W, 1%	7867
14	Switch, Rotary (C3-3381)	7893

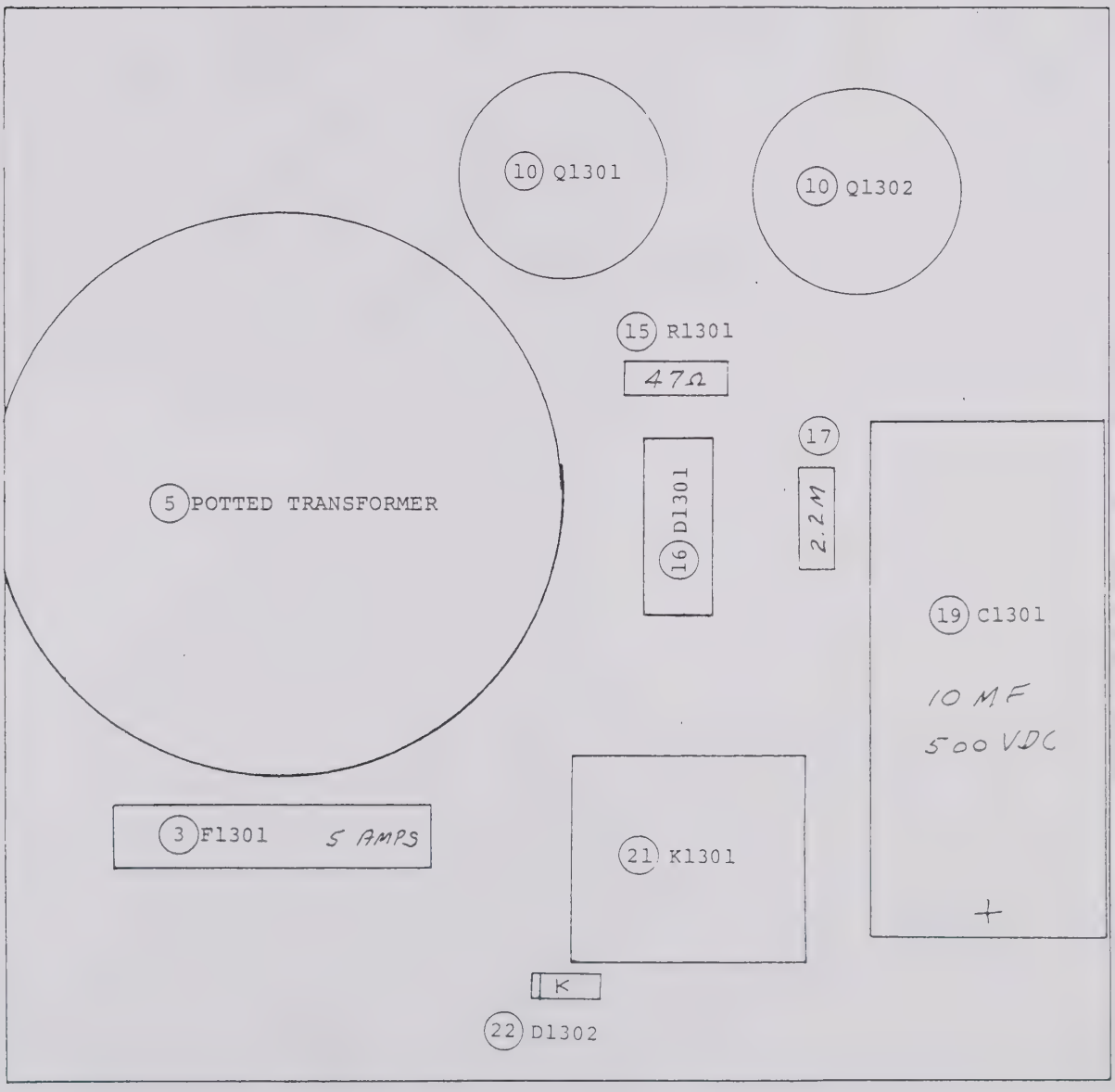
CONVERTER AND BATTERY PACK
PART NO.7935/D2-3310, Sh's.,1 and 2



CONVERTER AND BATTERY PACK
Part No. 7935/D2-3310, Sheets 1 and 2
ELECTRICAL SCHEMATIC, D6-3560, Sheet 1

REF. NO.	DESCRIPTION OF PART	PART NO.
--	Converter and Battery Pack Assembly	7935
--	Bracket for Battery Housing/C4-3306	7802
--	Mounting Plate for Converter and Battery	7805
9	Battery (B1304), Ni Cad, 6.0 Volts (D2-3310, Sheet 1)	7895
10	Battery (B1302 & 1303), Ni. Cad, 12 Volts (D2-3310, Sheet 1)	7896
--	Battery Pack Assembly	10255
--	Battery Retaining Clip (D2-3310, Sheet 2)	7804
9	Battery (B1301), Ni. Cad., 3.6 Volts (D2-3310, Sh. 2)	7894
--	Converter Board (See 7928 Illustration and Parts List)	7928

CONVERTER POWER SUPPLY
PC BOARD ASSEMBLY
PART NO. 7928/C2-3412
Electrical Schematic, D6-3560, Sh.2



CONVERTER POWER SUPPLY
BOARD 1300
Part No. 7928/C2-3412
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

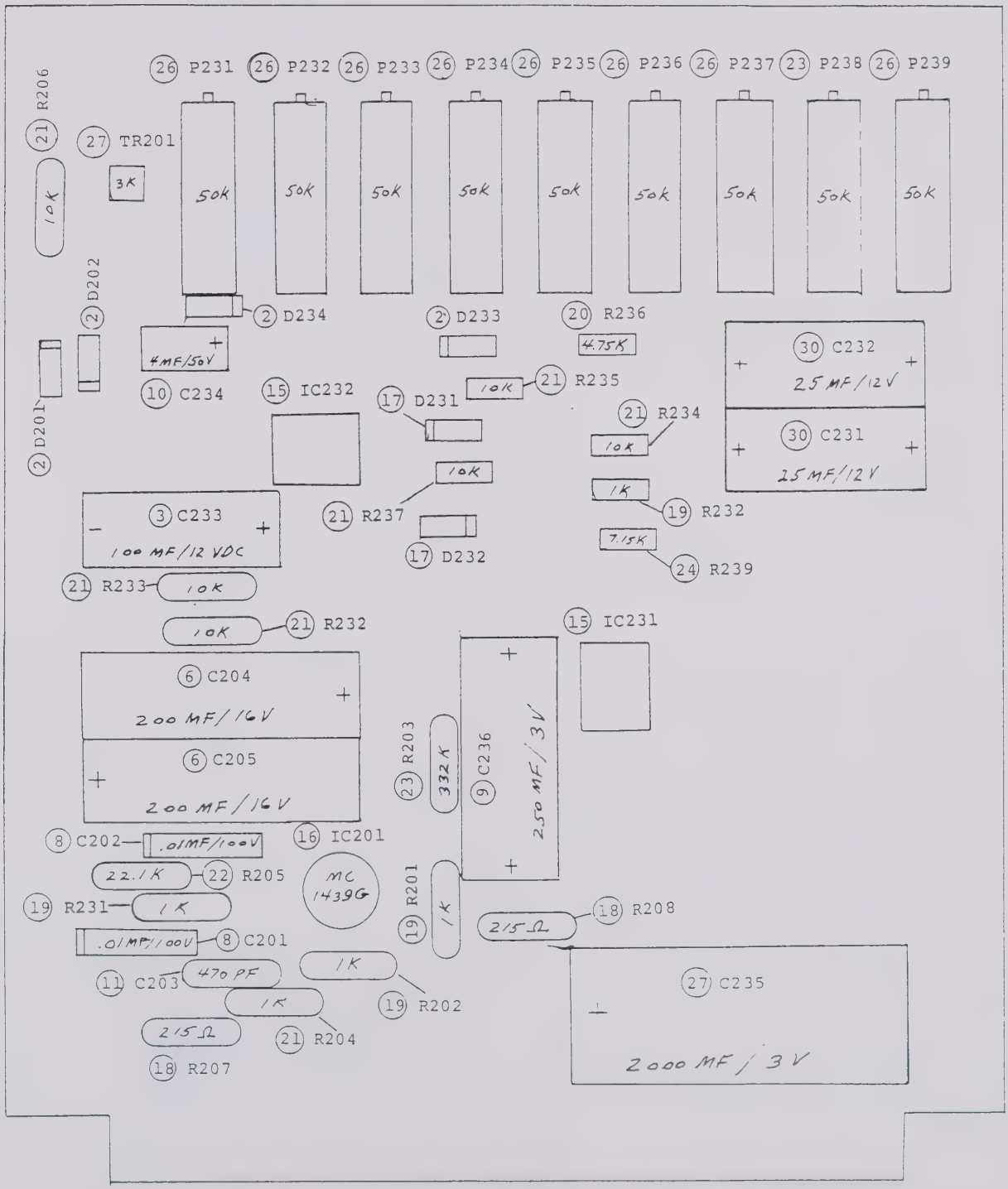
REF. NO.	DESCRIPTION QF PART	PART NO.
1	PC Board Assembly	7928
2	Basic PC Board	7708
3	Fuse (F1301), 5-Ampers, 3AG, Slo Blo	3849
4	Fuse Clip (2 Req'd)	8562
5	Transformer, Potted Converter	9103
10	Semiconductor (Q1301 & 1302), 2N3611	4584
15	Resistor (R1301), 47 ohms, 1/2 W, 5%	4337
16	Semiconductor (D1301) FWL 600 (Bridge Rect.)	7834
17	Resistor, 2.2 Meg ohms, 1/2 W, 5%	1618
19	Capacitor (C1301), 10MF, 500 Vdc, El.	4686
21	Relay (K1301), SPDT, PC Mount	9142
22	Semiconductor (D1302), 1N3279, Diode	4580

TWIN T FILTER
PART NO. 7929/C2-3413
Electrical Schematic No. D6-6560

TWIN T FILTER
BOARD 900
Part No. 7929/C2-3413

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly	7929
4	Basic PC Board	7709
5	Capacitor, Filter	8351
6	Capacitor, Padding	9758

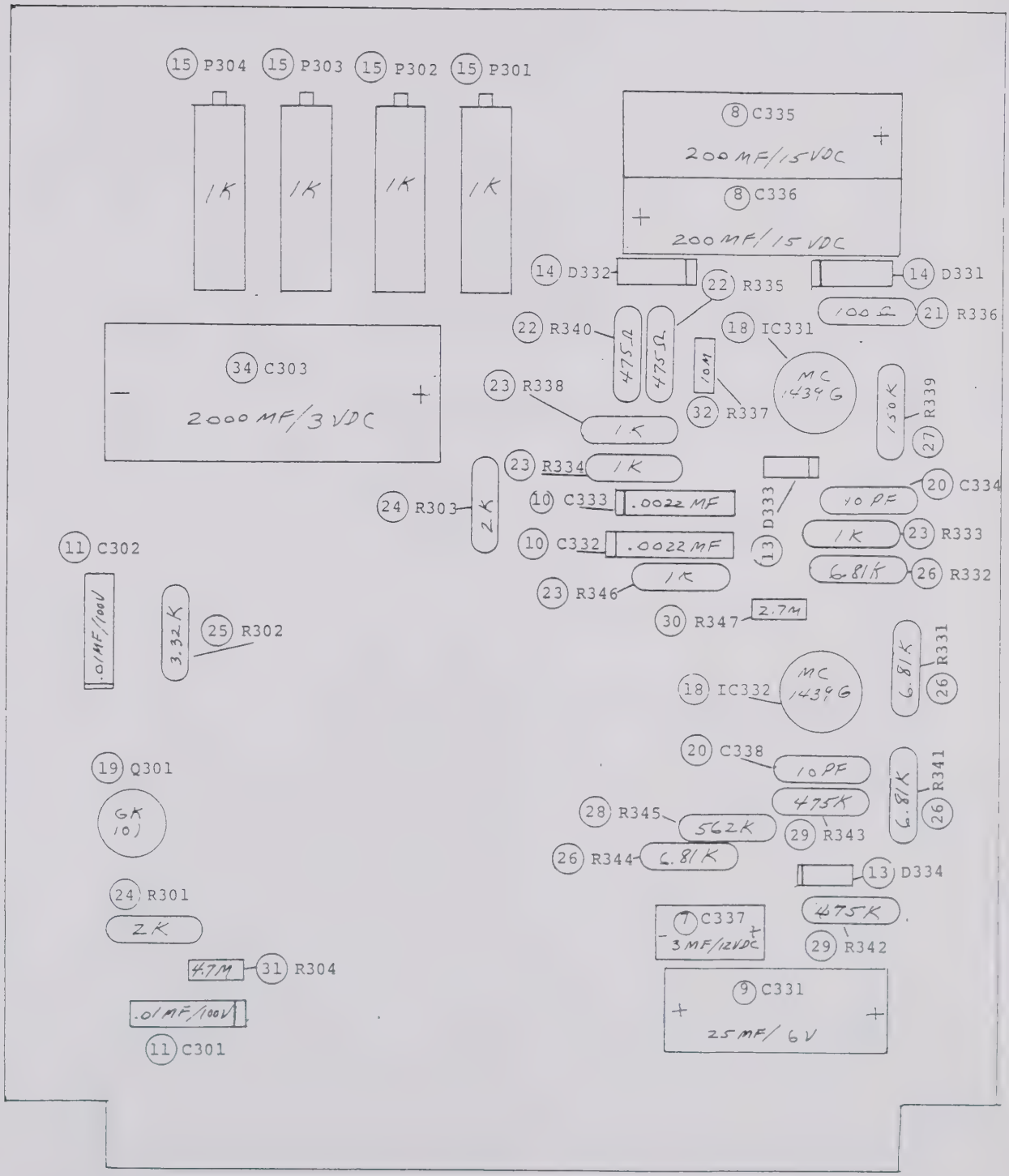
FILTER METER AMP.
PART NO.8422/C2-3754
Electrical Schematic, D6-3560, Sh.2



FILTER-METER AMP
BOARD 200
Part No. 8422/C2-3754
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly/C2-3754	8422
2	Semiconductor (D201, 202, 233, 234), 1N67A, Diode	1380
3	Capacitor (C233), 100 MF, 12 Vdc, El.	3605
6	Capacitor (C204, 205), 200 MF, 16 Vdc, El.	3533
8	Capacitor (C202, 201), 0.01 MF, 100 V	4572
9	Capacitor (C236), 250 MF, 3V (Non-polarized)	5023
10	Capacitor (R234), 4 MF, 50 Vdc, El.	5032
11	Capacitor (C203), 470 PF, 500V	5391
13	Basic PC Board/C4-3753	8412
14	Pad, IC, 8-Pin	7767
15	Semiconductor, Mini (IC231-232), IC-741	8555
16	Semiconductor (IC201), MC14396, IC	7827
17	Semiconductor (D231-232), 1N914A, Diode	5398
18	Resistor (R207, 208) 215 ohms, 1/8 W, 1%	7844
19	Resistor (R202, 201, 231, 232), 1K ohm, 1/8 W, 1%	7848
20	Resistor (R236), 4.75K ohms, 1/8 W, 1%	7856
21	Resistor (R206, 237, 232, 233, 204, 234, 235), 10K ohms 1/8 W, 1%	7859
22	Resistor (R205), 22.1K ohms, 1/8 W, 1%	7863
23	Resistor (R203), 332K ohms, 1/8 W, 1%	7870
24	Resistor (R239), 7.15K ohms, 1/8 W, 1%	9297
26	Potentiometer (P231 thru 239), 50K ohms, Multi-turn	8338
27	Capacitor (C235), 2000 MF, 3Vdc, El.	8397
28	Thermistor (TR201), 3K ohms, ±5%	5897
30	Capacitor (C231, 232), 25 MF, 12V (non-polarized)	5464

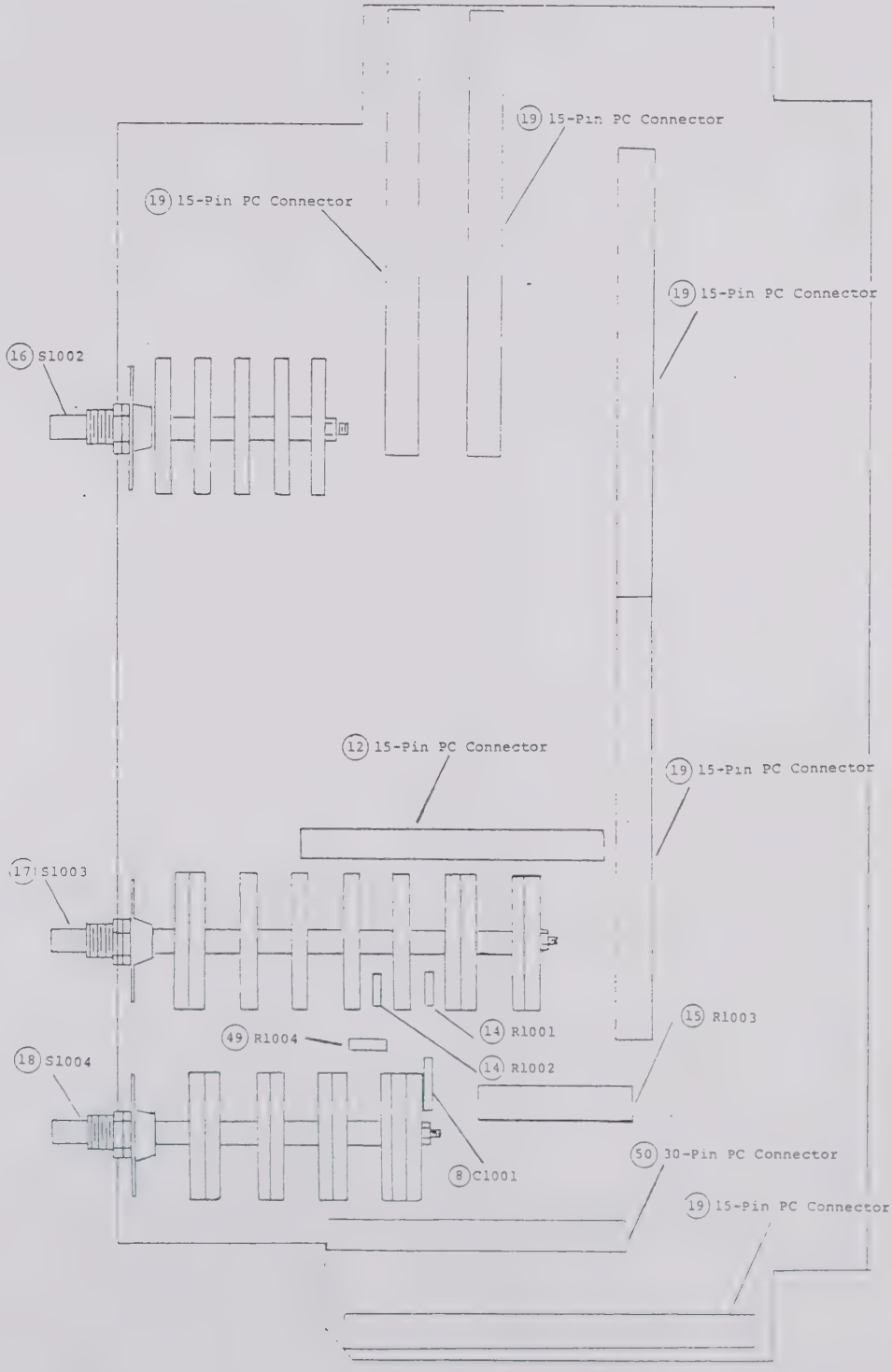
LIMITER THRESHOLD PC BOARD
PART NO. 8423/C2-3755
Electrical Schematic, D6-3560, Sh. 2



LIMITED, THRESHOLD
BOARD 300
Part No. 8423/C2-3755
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly/C2-3755	8423
7	Capacitor (C337), 3 MF, 12 Vdc, El.	3530
8	Capacitor (C335, 336), 200 MF, 15 Vdc, El.	3533
9	Capacitor (C331), 25 MF, 6V (non-polarized)	3568
10	Capacitor (C333, 332), 0.0022 MF, 100 V	4571
11	Capacitor (C302, 301), 0.01 MF, 100 V	4572
13	Semiconductor (D333, 334), 1N914A, Diode	5398
14	Semiconductor (D331, 332), 1N5231, Zener 5.1V, Diode	5399
15	Potentiometer (P301, 302, 303, 304), 1K ohm	8336
16	Basic PC Board	7703
17	Pad, 8-Pin (for IC331 and 332)	7767
18	Semiconductor (IC331, 332), MC 1439G	7827
19	Semiconductor (Q301), GK 101	7828
20	Capacitor (C334, 338), 10 PF, 500V	7835
21	Resistor (R336), 100 ohms, 1/8 W, 1%	7843
22	Resistor (R335, 340), 475 ohms, 1/8 W, 1%	7845
23	Resistor (R333, 346, 338, 334), 1K ohms, 1/8 W, 1%	7848
24	Resistor (R301, 303), 2K ohms, 1/8 W, 1%	7850
25	Resistor (R302), 3.32K ohms, 1/8 W, 1%	7854
26	Resistor (R331, 332, 341, 344), 6.81K ohms, 1/8 W, 1%	7857
27	Resistor (R339), 150K ohms, 1/8 W, 1%	7869
28	Resistor (R345), 562K ohms, 1/4 W, 1%	7872
29	Resistor (R335, 343, 342), 475K ohms, 1/8 W, 1%	7871
30	Resistor (R347), 2.7 Meg ohms, 1/4 W, 5%	7875
31	Resistor (R304), 4.7 Meg ohms, 1/4 W, 5%	7876
32	Resistor (R337), 10 Meg ohms, 1/4 W, 5%	7877
33	Pad, Dual FET MTG (for Q301)	7914
34	Capacitor (C303), 2000 MF, 3 Vdc, El.	8397

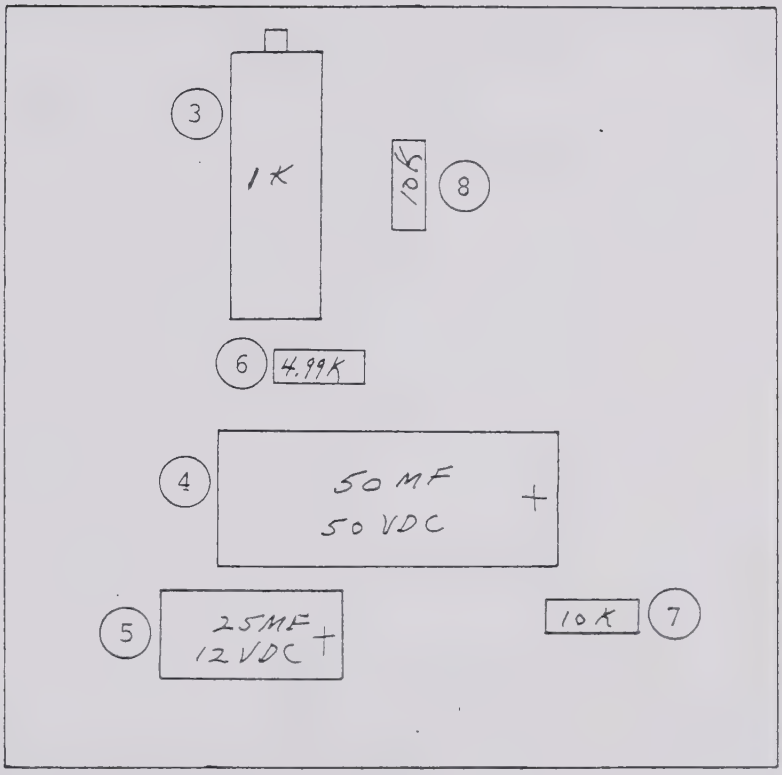
MAIN PC BOARD
PART NO.8430/D2-3757
Electrical Schematic, D6-3560, Sh.2



MAIN PC BOARD ASSEMBLY
Part No. 8430/D2-3757
ELECTRICAL SCHEMATIC, D6-3560, Sheet 2

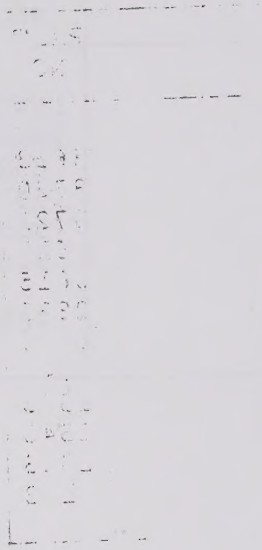
REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board Assembly	8430
8	Capacitor (C1001), 0.01 MF, 1KV	4573
12	Connector, 15-Pin, PC	7643
13	Basic PC Board	8410
14	Resistor (R1001, 1002), 4.75K ohms, 1/8 W, 1%	7856
15	Resistor (R1003), 36 ohms, 10 W, 5%	7882
16	Switch (S1002), Filter/C3-3378	7890
17	Switch (S1003), Freq. Range/D3-5719	10578
18	Switch (S1004), Power/D3-3380	7892
19	Connector, PC (5 Req'd)	9348
49	Resistor (R1004), 100 ohms, 1/2 W, 5%	1584
50	Connector, 30-Pin, PC	9349

X-Y PLOTTER
PC BOARD ASSEMBLY
PART NO. 10455/B2-5549



X-Y PLOTTER
PC BOARD ASSEMBLY
Part No. 10455/B2-5549

REF. NO.	DESCRIPTION OF PART	PART NO.
1	PC Board, Assembly	10455
2	Basic PC Board	10454
3	Potentiometer, 1K ohms, 3/4 W, 10%	8336
4	Capacitor, 50 MF, 50 Vdc, El.	5034
5	Capacitor, 25 MF, 12 Vdc, El.	3532
6	Resistor, 4.9K ohms, 1/8 W, 1%	9105
7 & 8	Resistor, 10K ohms, 1/8 W, 1%	7859



STROBE CABLE ASSEMBLY
Part No's. 8763, 8720, or 8721/B2-3879

DESCRIPTION OF PART	PART NO.
Cable Assembly, 12-Feet	8653
Cable Assembly, 25-Feet	8720
Cable Assembly, 50-Feet	8721
Connector, 5 Cond. Male	8617
Connector, 5 Cond. Female	8615
Cable, 4 Cond., 20 Ga., Shielded (Specify length)	2835
Solder, 60/40 Flux	2365
Spaghetti, No. 12 Silicon Rub	2344
Band, Aluminum	1343
Spaghetti, No. 10, Silicon Rub	2343
Wire, No. 22 Ga. Solid, Bare	2363
Tubing, 1/2-Inch, Shrinkable	8173

NOTE: Specify quantity or length for Items 4, 5, 6, 7, 8 and 9.

MP MASTER
MA34743